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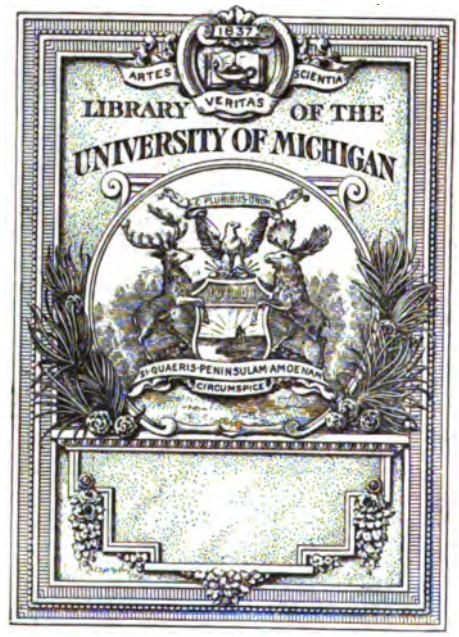
E. M. Hunt.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TWENTIETH ANNUAL REPORT

OF THE

STATE BOARD OF AGRICULTURE

OF THE

STATE OF MISSOURI

FOR THE YEARS 1887-'88.

JEFFERSON CITY, MO.:
TRIBUNE PRINTING COMPANY, STATE PRINTERS AND BINDERS.
1888.

IN MEMORIAM.

In the death of Governor John S. Marmaduke there is occasion for an expression on the part of the Board of Agriculture, in view of the great interest shown by him in the Agriculture of the State, he having been a native Missourian, being the first native born Governor the State has had, also having been the son of a Missouri farmer and at one time officially connected with this Board and the editor of an agricultural journal:

Resolved, That we feel called on to join our fellow citizens in expressing sincere regret on the removal of Governor Marmaduke from his high official place in the midst of his administration, marked by a painstaking and unswerving integrity, but would bow reverently and submissively to the Allwise Providence who has so ordered.

Resolved, That we extend to the family of the deceased our sympathy in their bereavement, and would commend them and all our State interests to Him who careth for us.

197481

STATE BOARD OF AGRICULTURE.

MEMBERS EX-OFFICIO.

His Excellency, A. P. Morehouse.
Hon. W. E. Coleman, Superintendent of Public Schools.
S. S. Laws, LL. D., President of University of Missouri and Agricultural College.
J. W. Sanborn, Dean of State Agricultural College.

APPOINTED BY THE GOVERNOR.

J. A. Potts, Esq., President.....Mexico, Audrain county.
Abiel Leonard, Esq., Vice-President.....Mt. Leonard, Saline county.
Hon. N. J. Colman, U. S. Commissioner of Agriculture..... St. Louis City.
John R. Rippey, Esq.....Glenwood, Schuyler county.
B. C. Cowan, Esq.....New Point, Holt county.
Judge J. W. Emerson.....Ironton, Iron county.
F. W. Smith, Esq.....Columbia, Boone county.
Jas. H. Fullbright, Esq.....Lebanon, Laclede county.
M. B. W. Harmon, Esq.....Pickering, Nodaway county.
M. F. Doud, Esq.....Kansas City, Jackson county.

J. W. SANBORN, Secretary.

BY-LAWS.

SECTION 1. The officers of the Missouri State Board of Agriculture shall consist of a President, Vice-President, Treasurer and Secretary.

SEC. 2. It shall be the duty of the President to preside at the meetings of the Board, to sign all warrants on the Treasurer ordered by the Board, and to perform such other duties as are or may me required by law. He shall be *ex officio* chairman of the executive committee. In his absence, the Vice-President shall perform his duties.

SEC. 3. It shall be the duty of the Secretary to keep and preserve the minutes and records of the Board, and the proceedings of the executive committee, to furnish a copy of the same for publication, previous to the expiration of his term of service, and to countersign all warrants on the Treasurer for money.

SEC. 4. The Treasurer shall keep the funds of the Board, and pay all warrants drawn by order of the Board, signed by the President and countersigned by the Secretary, and shall make his report at the annual meeting in November, of his receipts and expenditures, from whence received and to whom paid, properly arranged for publication. He shall give bond in such penal sum as may be required by the Board for the faithful performance of his duties, and the payment of all moneys in his hands.

SEC. 5. It shall be the duty of the Secretary to conduct all correspondence with societies and individuals; to issue such circulars for obtaining statistics or other information as the Board may direct, or as may be deemed expedient or useful; to collate and arrange the correspondence, proceedings of the Board and the proceedings of the county societies for report and publication, as required by law, and distribute to county societies and others entitled to them, all seeds, plants, publications, etc., which may be acquired by the Board for distribution. His term of office shall hereafter commence the first day of March, and continue one year, and until his successor is elected.

SEC. 6. The President, Vice-President and Secretary shall constitute an executive committee, whose duty it shall be to inspect and audit all accounts, to inspect and pass upon all papers entering into the annual report, and to perform such other duties as may be required of them in the intervals between the meetings of the Board.

SEC. 7. The President shall have authority to call special meetings of the Board whenever he may deem it necessary or important to do so.

SEC. 8. These by-laws may be altered or amended at any annual meeting of the Board: *Provided*, that any member proposing to amend the by-laws at said

meeting of the Board, shall give two weeks' notice prior to said meeting, to all the corporate members or their successors in office, of such intended motion to amend.

SEC. 9. The records of the proceedings of the Board shall at all times be open to the inspection of the members.

SEC. 10. Any corporate member, who shall be absent at two successive meetings (one of which shall be the annual meeting), shall forfeit his membership, and the Board may declare a vacancy in consequence thereof.

LAWS CONCERNING

THE

STATE BOARD OF AGRICULTURE

AND

COUNTY AGRICULTURAL AND MECHANICAL SOCIETIES.

STATE BOARD OF AGRICULTURE.

SECTION 4042. *Board of Agriculture created*—A Board of Agriculture is hereby instituted and created a body corporate, by the name and style of the "Missouri State Board of Agriculture," and by that name shall have perpetual succession, power to sue and be sued, complain and defend in all courts, to make and use a common seal, and to alter the same at pleasure.

SEC. 4043. *Who shall constitute Board—shall meet and elect officers, when and where—salaries.*—The persons named as corporators of the Missouri State Board of Agriculture heretofore existing, are hereby constituted the members of the Missouri State Board of Agriculture, under this article, and there shall be a meeting of said Board of Agriculture as constituted by this article, held at the Agricultural College Building of the State University, on the second Wednesday of July, 1877, to elect a President, Secretary and Treasurer, and such other officers and agents as the Board shall deem necessary. And no officer, so appointed or elected by the said Board, shall receive any salary for his services, except the Treasurer and Secretary, and the salary of the Treasurer shall not exceed forty dollars per annum, nor shall the Secretary receive more than six hundred dollars per annum; and all the offices of the present Board of Agriculture are hereby declared to be vacant from and after the time when this act takes effect. (Laws 1877, p. 5, § 2.)

SEC. 4044. *Who are ex officio members of the State Board.*—The Governor, the State Superintendent of Public Schools, the President of the State University and the Dean of the Agricultural College, shall be *ex officio* members of the State Board of Agriculture, and the Governor shall appoint practical farmers to fill all vacancies as they occur in the corporate members of said Board of Agriculture. (Laws 1877, p. 5, § 3.)

SEC. 4045. *Officers to be elected, when—term of office.*—The officers of said Board of Agriculture shall be elected at the annual meeting of said Board, except those elected as provided for in section four thousand and forty-three, who shall serve for one year and until their successors are elected and qualified; and the offices of the Secretary and Treasurer shall be in the Agricultural College Buildings of the State University, in the town of Columbia, Boone county. (Laws 1877, p. 6, § 4.)

SEC. 4046. *Board to adopt by-laws.*—The Missouri State Board of Agriculture, and their successors, shall have power to adopt such by-laws and make such rules and regulations for the government of said Board and the management of its affairs and business, as they may deem best calculated to promote the interest of agriculture, and shall not be inconsistent with the Constitution and laws of the State of Missouri and of the United States. (G. S. 320, § 5.)

SEC. 4047. *Annual meetings—membership.*—There shall be held in the Agricultural College Building aforesaid, on the first Wednesday of November, in each year, an annual meeting of the State Board of Agriculture, together with the president of each county agricultural society, or delegate therefrom, duly authorized, who shall for the time being be *ex officio* members of the State Board of Agriculture, for deliberation and consultation as to the wants, prospects and condition of the agricultural interests of the State, to receive the reports of district and county societies, and to fill by elections all vacancies in the Board. The President shall have power to call meetings of the Board when he may deem it expedient, and at any meeting of said Board, seven members shall constitute a quorum; and all meetings of the Board shall be held at the place of holding the regular meetings of the Board, in November of each year. (Laws 1877, p. 6, § 6.)

SEC. 4048. *Agricultural and Horticultural Societies to make report to Board.*—It shall be the duty of all agricultural and horticultural societies, organized and established in accordance with the laws of this State, to make a full report of their transactions to the Missouri State Board of Agriculture, at each annual meeting thereof. (G. S. 320, § 7.)

SEC. 4049. *Board shall make annual report to General Assembly—report shall contain, what.*—It shall be the duty of the said Board to make an annual report to the General Assembly of the State, embracing the proceedings of the Board for the past year, and an abstract of the reports and proceedings of the several agricultural and horticultural societies, as well as a general view of the condition of agriculture and horticulture throughout the State, accompanied by such recommendations, including especially such a system of public instruction upon those subjects as may be deemed interesting and useful (G. S. 320, § 8.)

SEC. 4050. *Printing and distribution of annual reports of Board.*—The public printer shall, annually, under the direction of the President of the State Board of Agriculture, print fourteen thousand copies, of which two thousand shall be in the German language, of the annual report of the said Board of Agriculture; five hundred copies to be bound in cloth, balance in paper covers, to be distributed as follows: Twenty copies to each member of the General Assembly, fifty bound copies to the State Library, thirty copies to each county clerk for distribution among the farmers, as generally as may be, and the remainder to the State Board of Agriculture, to be distributed among the several agricultural and horticultural societies and farmers' clubs of this State and other States, as the Board may direct: Provided, that said annual report shall not contain more than five hundred pages. (Laws 1875, p. 3, § 1.)

COUNTY AGRICULTURAL AND MECHANICAL SOCIETIES.

SEC. 4051. *Associations for the purpose of agriculture, etc., may be incorporated, when—powers, etc.*—Whenever fifty freeholders within this State shall present a petition to the county court of the county in which they or a majority of them reside, setting forth that they desire to organize and be incorporated for the purpose of promoting improvements in agricultural manufactures and the raising of stock, and the court shall be satisfied that such persons are freeholders of this State, the court shall, by an order, declare the petitioners incorporated for the purposes specified in this section, and thenceforth the petitioners shall be a body politic and corporate, by the name and style of the (naming it) county agricultural and mechanical society, and by that name they and their successors shall be known in law, have perpetual succession, sue and be sued, plead and be impleaded, defend and be defended, in all courts and in all actions, pleas and matters whatsoever, and shall have power to purchase, hold and receive any quantity of land not exceeding one hundred acres, with such buildings and improvements as may be placed thereon, and any other property, not exceeding in value fifty thousand dollars; and may, by vote, determine that thereafter the members of said society shall be composed of such persons as shall subscribe at least one share to the capital stock thereof, in shares not exceeding twenty-five dollars each; said shares to be personal property and transferable by agreement; but no transfer shall be binding on the society until reported to and approved by the board of directors. The amount of such capital stock shall, from time to time, be fixed by the stockholders or board of directors, provided the same shall, at no time, exceed one hundred thousand dollars, and may convey, lease, sell and dispose of the property of the society, or any part thereof, for the benfit of the society, and may have a common seal, and break and alter the same at pleasure. (Laws 1867, p. 3, § 1.)

SEC. 4052. *Directors to be elected, when—term of office—powers and duties—vacancies, how filled—who shall not be a director.*—Within thirty days from the date of the order of the county court, any number of the petitioners exceeding twenty, may proceed to organize such society by electing nine directors, who shall hold their offices one year, and until their successors are elected; and the directors, when so elected, shall collectively form a board for the government of such society; and in such board shall be vested all the corporate powers and duties of every society incorporated as provided in this article; and for the purpose of electing the directors, there shall be held, annually, a general meeting of the members of the society. All vacancies in the board of directors shall be filled by appointment of the board. No person, not a member of the society, shall be a director. (G. S. 321, § 2.)

SEC 4053. *Directors to meet and select officers, when.*—Every board of directors shall assemble within twenty days after their election, and choose a president of their number, and some other persons as secretary, treasurer, collector and such

other officers, servants and agents as may be necessary, remove them from office and prescribe their duties; and all proceedings of the board shall be public. (G. S. 321, § 3.)

SEC. 4054. *Duty of officers.*—It shall be the duty of the president to preside at all meetings of the board and of the society, and in case of his absence, such other person as the members present shall appoint; and it shall be the duty of the secretary to keep a record of the proceedings of the directors and of the society; and the treasurer shall give bond and security, to the acceptance of the board of directors, for the benefit of the society, in such sum as they, or a majority of them, shall determine, conditioned that he will faithfully receive and pay over, on their order, all moneys or other articles, the property of the society, that may come into his hands as treasurer, which bond shall be deposited with the secretary of the board of directors; and the said treasurer shall keep fair and accurate entries of all moneys and other articles by him received as treasurer, and from whom received, and to whom and for what purposes paid out, and make report of the financial operations of his office as often as he may be directed by the board of directors. (G. S. 322, § 4.)

SEC. 4055. *Majority of board a quorum—general powers.*—The said board, a majority of whom shall form a quorum, shall have power to make, ordain and adopt a constitution and all necessary by-laws, ordinances, rules and regulations for the government of the board of directors and of the society, and for the promotion of the objects for which it is designed; and the president of the board shall cause the same to be carried into effect; provided, such constitution, by-laws, ordinances, rules and regulations shall not be inconsistent with the Constitution and laws of the State. (G. S. 322, § 5.)

SEC. 4056. *Money to be appropriated, how.*—All moneys paid by members and others, and donations made to the society, shall be appropriated, under the direction of said board, in conformity to such constitution, by-laws, rules and regulations as may be ordained and established for the government of the society, and for the advancement and encouragement of the objects of the society. (G. S. 322, § 6.)

SEC. 4057. *County court may appropriate money to the society, when.*—The county court of any county in which there shall be a society organized according to this article, or any special act of incorporation, shall have the power and may, if it shall be deemed expedient, appropriate out of the county treasury, for the benefit of the society, the sum of one hundred and fifty dollars in any one year; and the money so appropriated shall be drawn by the treasurer of the society on a proper warrant; provided, said money shall be annually awarded by the board of directors in premiums, or expended by them in the purchase of premiums, to be known as "the (name the county) court premiums," to be awarded according to the rules, regulations and by-laws of the society; and provided further, that not more than one such premium shall be awarded to the same animal or article of exhibition by the same county society. (G. S. 322, § 7.)

SEC. 4058. *Directors to repoit at each annual meeting—copy of report to be transmitted to State Board of Agriculture.*—At each annual meeting of the society, the board of directors shall report, in writing, the number of members and the financial condition of their society; the quantity and character of property owned by it, and the quality and cost of improvement of the same; the number and value of premiums awarded at their annual fair; the number and character of the animals and articles exhibited; a statement of the probable quantity of the staple commodities of the county, and the prices current thereof, and such other information

in relation to the agricultural and mechanical interests of the county, as they may deem worthy of general notice; and a copy of the reports so made shall be transmitted to the Missouri State Board of Agriculture, to be disposed of as provided in the next succeeding section. (G. S. 322, § 8.)

SEC. 4059. *State Board to report to General Assembly.*—The Missouri State Board of Agriculture shall, at each session of the General Assembly of the State of Missouri, report faithfully all the facts, statistics and information contained in the reports transmitted to them from the county agricultural and mechanical societies, organized and incorporated under the provisions of this article, and such other facts, statistics and information as they may gather from other counties in this State in regard to agricultural, mechanical and domestic manufactures and productions, and to the raising of the various breeds of stock. (G. S. 323, § 9.)

SEC. 4060. *Property shall be held, for what purpose.*—The land and other property which may be held by any society under the provisions of this article, shall be held by the society for the sole purpose, and none other whatsoever, of erecting inclosures, buildings and other improvements calculated and designed for meetings of the society, and for exhibition of various breeds of horses, cattle, mules, and other stock, and of agricultural, mechanical and domestic manufactures and productions, for the purchase and importation, and the keeping thereof, of such foreign breeds of stock as the board of directors may deem advantageous to the interests to the country. (G. S. 323, § 10.)

SEC. 4061. *Who shall be members.*—The members of any society, organized under the provisions of this article, shall be composed of such persons, and none others, as shall have subscribed their names as such in the books in which the proceedings of the society and of the board of directors are or shall be recorded, and paid annually to the treasurer of the society such sum, not exceeding five dollars in any one year, as may be established by the rules, by-laws and regulations of the society as a membership fee; and such persons shall be members only for the year for which they shall have paid such fee. (G. S. 323, § 11.)

SEC. 4062. *Order of incorporation to be recorded.*—A duly authenticated copy of the order of the county court, provided for in section four thousand and fifty-one, shall be filed and recorded in such manner as conveyances of land are, by law, directed to be recorded in the office of the recorder of the county, within three months after such order shall be made. (G. S. 323, § 12.)

SEC. 4063. *Constitution, etc., shall be printed, etc.*—The constitution, by-laws, rules and regulations of the society and board of directors shall be printed and circulated among the members of the society within thirty days after their adoption. (G. S. 323, § 13.)

SEC. 4064. *Property shall be sold, when.*—Whenever a majority of two-thirds of the members of any society organized under the provisions of this article, shall, at an annual meeting, declare such society dissolved; or if, from any other cause, said society shall be dissolved or fail to meet and pursue the objects of the society for the period of five consecutive years, then the real estate and all other property held by it shall be sold for cash in hand, at public auction, before the court house door of the county, after thirty days notice given in some newspaper published in the county, if there be one, and, if not, by ten printed advertisements set up in ten public places in the county, describing the property to be sold, and the time, place and terms of sale. Such sale shall be conducted by the directors, or a majority of them, chosen and elected as provided by this article. (G. S. 323, § 14.)

SEC. 4065. *Parties guilty of misconduct shall be arrested, etc., when.*—At any fair, show or exhibition, held by any incorporated agricultural and mechanical society,

every person who shall, without the permission of the officers of such society, enter within any inclosure which may be used by such society as an agricultural and mechanical fair, and every person guilty of disorderly conduct, or such conduct as may interrupt or be prejudicial to the interests of such fair or exhibition whatever, within the enclosure for the same, or at a distance within two hundred yards of such inclosure, shall be liable to immediate arrest by any officer of such society, and to the payment of five dollars to the society holding such fair, show or exhibition, to be recoverable at the suit of such society before any justice of the peace of the county in which such fair, show or exhibition may be held. (G. S. 323, § 15.)

SEC. 4066. *Societies may perpetuate their organization, when.*— All agricultural societies in this State, established under the act above cited, and that have failed to keep up their organizations as required by the law approved November 23, 1855, are hereby authorized and empowered to pursue the objects of such societies and perpetuate their organization as though no failure to observe the law had occurred. (G. S. 324, § 16.)

TWENTIETH ANNUAL REPORT

OF THE SECRETARY OF THE

MISSOURI STATE BOARD OF AGRICULTURE

To the General Assembly of the State of Missouri:

The crop season of 1887 has been in its main characteristics a duplication of that of 1886, much intensified. Like the season of 1886, it opened with the most cheering prospects for crops. Wheat was favored both winter and spring, and I record the largest and best wheat crop raised in recent years in Missouri. In this regard it was perhaps the most favored State of the Union.

Before the blighting influence of the subsequent drought was felt in its full force, a good crop of oats was harvested, and a medium crop of clover. Corn, which promised down into July, to be one of the best, if not the best crop raised in the history of the State, harvested considerably less than an average crop, while timothy, and especially potatoes and all late crops, suffered severely. The table of crop yields found in another part of the report, will give the total for each one of our staple crops.

Another table will reveal the rain fall of the season. It will show a very great seasonal deficiency of rain, especially for the latter half of the year, and that this monthly deficiency of rain fall continued until the opening of winter. Its decided effect upon our pastures, which have suffered severely, can only be understood in connection with the fact that the water in the soil, at the opening of the season, was impaired in amount through the failure of an average rain fall for the year 1886.

No interest of our farmers has been so decisively and injuriously affected as our cattle investment. The influence of droughts in restricting growth of stock and in encouraging the marketing of half fattened cattle below rates, has been supplemented by falling prices for this class of domestic animals. This decline of prices has been caused by another set of facts. We need not inquire for the moving causes.

The result is that the most important interest in the State is at the lowest ebb of prosperity it has seen for nearly a generation.

Along the farmer's business horizon there has been seen little to cheer him, growing out of his year's labor. If we turn to our grand wheat crop, we are met by the lowest range of prices seen in the great markets for a century, while in our local markets per pound of nutritive value contained in it, wheat has sold in parts of the State at practically the same price as corn. The combined influence of drought and the market has again forced our wheat area down, and for this year compared with 1886, but 91 per cent. of ground is sown in this bread crop. Compared with 1884, we have now but 65.5 per cent. the area to wheat that we then had, or 1,310,236 acres.

This radical change in our farm polity regarding this great cash crop, grows out of profound moving causes. The policy of selling the raw products of our soil has lowered the level of our crop yield to a non-paying point. It is usually stated that competition has broken down the markets. I think it will be proven that the farming world, for various causes, is now ready to furnish wheat at a lower range of prices than it could furnish it for a few years ago, and that the true policy of our farmers is to modify their system of farming and to intensify their methods.

Against the results of the multiplication of lines of transportation and farm machinery in regions of the world where cheap manual labor abounds, the American farmer must put the product of brains. The supremacy of our agriculture rests in its intelligence, and in its intelligence alone can it be maintained and with it our superior order of society.

That science has important bearings upon the practice of agriculture has passed beyond the region of conjecture into established certainty. Public faith in law, as applied to farming, is having a most remarkable development. The recent circular sent out to 1,050 men, representing every county of the State, and bearing this question: "Do you favor placing an elementary tax book of agriculture in our common schools?" received a very large affirmative vote, and only a very few negative replies. A part of the replies to the question will be found in the body of the report.

Doubtless the 35th General Assembly will be asked to make some provision for such a text-book.

MORE GRASS.

The reduced area of wheat noted, has been accompanied by an increased area of grass. This correct and vitally important movement towards more meadow grass began before the ebb in wheat area began. The following table will show this:

PER CENT. OF TOTAL FIELD CROPS IN MEADOW GRASS.

	Per cent.
1880	8.3
1881	9.6
1882	10.3
1883	10.6
1884	11.4
1885	12.4

The total areas for last year and this are not at hand from the government statistical department from which the figures were drawn, but the returns to this office show a continuous gain of area.

H. J. Waters, B. A. S., a graduate of the Missouri Agricultural College Class of 1886, and assistant in the office of the Secretary of this Board, has prepared a very valuable paper setting forth the underlying reasons in favor of enlarging our area of grass at the expense of the tillage area. I believe the truths set forth to be fundamental and intimately related to the future wealth of our State. Heavy demands rest upon our agriculture. It has a transition state before it of a sharply defined character. In my last report to your honorable body, I indicated one of its radical needs, and have in this report, in Bulletin No. 29, a partial demostration of the views therein stated. In this report will be found the paper of Mr. Waters, which will set before us the reasons for another line of departure which is in full accord in its principles with those laid down in the article just alluded to.

By arrangement with Mr. Waters, I have taken the subject where he leaves it, having had a long experience with the culture of grass, introducing the subject by a brief review of the principles laid down by him.

As Mr. Waters, at his own suggestion, has taken up the relation of the grass to a better line of farming, or has given scientific reasons for the increase of our grass area, I will merely give a skeleton review of the reasons which favor an enlarged grass area, and then discuss the growth of grasses, basing my remarks upon a long and varied experience.

GRASS VERSUS TILLAGE CROPS.

Tillage crop farming is accompanied by the sale of crops from the farm and all of their fertility extracted from the soil. The result of this process is inevitable soil exhaustion.

The amount of phosphoric acid, potash and nitrogen thus yearly extracted does seem small when only about 160 pounds are involved in a crop of 50 bushels of corn and its fodder, yet by the use of 64 pounds of potash I have increased a crop of corn 30 to 40 bushels per acre. The amounts of available or soluble plant food in the soil is always comparatively minute, otherwise the soil would rapidly leach away.

The sale of raw products is never an enriching process. It is a sale of brawn and not of brain. Our object should be to work all of our crops up into their manufactured products, as it were, or beef, pork, wool, eggs, butter, etc.

The loss of soil fertility by sale crops is not the chief loss in tillage farming of plant food. It seems that all through nature wrong practices entail their own punishment. In case of excessive tillage it comes in the form of surface washing, volatilization through excessive soil decomposition of organic matter by the increased and excessive areation of the soil and by a greatly increased degree of soil leaching.

The extent to which this excessive degree of tillage is carried forward few realize. It amounts to 87 per cent. of the arable area now in tillage for this State; or, in other words, but about 12 per cent. of our arable crops was in meadows in 1885, which was an increase over 1880 from 8 and a fraction per cent.

England has over 50 per cent. in grasses and some New England States had over 85 per cent. in grasses in 1880. All high agriculture throughout the world is based in modern civilized nations upon a large area of meadow grasses.

The loss by tillage in the form of surface washing from our fine soils is enormous, and its influence faintly seen in the figures given by Mr. Waters for the Mississippi river, in one direction only. The binding roots of grasses with their covering sod obviate the greater part of this loss.

It is difficult to measure the loss from oxidation of organic matter by the constant and free access of air to soil in continued tillage of the surface. Sir John B. Lawes has shown that it amounts to a reduction of one-half, and the consequent decrease of the invaluable nitrogen of the soil in the same ratio. This serious loss is accompanied by a decreased capacity of the soil to hold water, inasmuch as organic matter or humus has several times the water-holding capacity that the minerals of the soil have. This loss of organic matter is accompanied by a compaction of the soil and a decreased power to retain plant food, the solutions from added manure, and has its ability to absorb air elements of plant food reduced, each of which affect the agricultural value of soils. Evidence is abundant to confirm this influence of excessive tillage. The most uninformed knows that the more air admitted to a fire in a stove the more rapid is combustion, and that a loose manure heap decomposes most rapidly—the rising smoke from loose horse manure being often visible evidence of this fact.

Soil leaching is a quite pronounced method of exit of soil fertility. All well and spring water contains both mineral and organic elements of plant food, while lysimeter waters from newly manured fields are very rich in plant food. Water of tile drains from tilled soils is very much richer in soil matters than from grass fields. Mr. Waters gives instances. Sir John B. Lawes shows this influence in his trials

Soils covered by grass not only contain more organic matter to retain soil fertility, but in point of fact, have but little water flow through them, as the grass evaporates it through its leaves.

Plenty of illustrations can be given of the assertion of Sir J. B. Lawes that the amount of nitrogen leached from his tilled fields is often in excess of that taken up by the crops grown. I only intend to hint at the evil effects of excessive tillage and so forego the demonstration as the subject is considered in several phases of its methods of loss by Mr. Waters. The losses by the methods recited are doubtless far in excess of the direct loss through sale crops, and aid in accounting for the phenomenal rapidity with which our soils have been depleted of their original fertility.

The relation of the grass crop to rotation is of very great interest. I will not dwell upon this valuable aid of grasses to successful farming. Alternating the grass crops with tillage crops is balancing the advantages of cover crops with their accumulating organic matter and nitrogen in the soil with roots to bind it against washing, with the good effects of tillage carried to just that extent that liberates this or-

ganic matter by decomposition under an areated soil but which does not pass to that point which involves rapid loss before it is again under a cover or partial cover crop.

HAY A HOME CONSUMPTION CROP.

The great bulk of the crops grown on the farm should be consumed upon the farm, manufactured into animal products by the grower, thereby accomplishing the double purpose of involving more labor in our farming and of leaving on the farm the resulting excrements of stock feeding. I have shown in a previous report that the great bulk of plant food in our stock food is voided by animals. This amount varies from 90 to 100 per cent. in the case of cattle, sheep and horses and 100 per cent. when cattle are not growing.

At present the use of yard manure is decidedly the most economical method of restoring and maintaining our soil fertility. Without maintaining a higher state of fertility for our farms a really successful agriculture in Missouri, one that will meet the world's competition, is out of the question.

If the principle of consuming on the farm that which is raised on the farm is to take deeper root, then grass will be found a peerless crop for that purpose.

It is nature's green velvety blanket thrown over the earth to conserve, as no other crop can, our soil fertility. It is the one crop which the digestive organs of our ruminating stock have become harmonized with, and which, intelligently grown, more nearly meets the demands of bone, muscle and fat than does any other single food. It is more easily grown, harvested, stored and fed than any known crop.

COMPARATIVE NUTRITIVE VALUE.

The above virtues place the grasses easily first as the world's royal crop for stock nutrition.

The table below which includes the best quality of hay and the whole plant of corn, against which the whole plant of grass should properly be compared and other crops, will afford a ready comparison of nutritive values so far as chemistry can aid us. Chemistry does not truly state the differences in feeding value of foods.

	Albuminoids.	Fats.....	Nitrogen free extract.....	Fibre.....	Ash.....	Total dry matter.....	Albuminoids.	Fats.....	Nitrogen free extract.....	Fibre.....	Ash.....
Corn fodder grown for fodder. And analyzed with corn on	4.29	1.24	35.96	22.14	4.32	67.95	6.31	1.82	52.95	32 58	6.35
Corn.....	10.59	5,49	69.13	2.10	1.55	89.46	11.83	6.14	77.21	2.34	1.73
Clover.....	11.44	2.02	39.87	26.69	5.33	85.35	13.05	2.36	46.71	31.48	6.24
Hay—Meadow.....	7.57	2.25	47.19	25.78	6.23	89.02	8.50	2.52	53.01	28.96	6.99

The six right-hand columns represent the analyses of the fodders in their air-dry states about as we expect to store them, and nearly as they would average at feeding time.

Inasmuch as the corn fodder contains much water I have reduced all the foods to a water-free condition, as seen in the five right-hand columns. The table reveals the fact that the whole corn plant is not as rich as good hay in albuminoids or flesh makers, while clover, which in practice is regarded as hay, is richer than corn in albuminoids. But we make the seed of the corn plant our great staple food, actually growing 6,295,728 acres of corn to 1,312,500 acres of hay. In this relation I note that the whole corn plant is poorer than hay in albuminoids and contains more fibre, and yet we rob the corn plant of the ear or seed and leave a very poor part as roughness to be mainly wasted, while we remove in seed only 26.4 bushels per acre for the State, or 1,478 lbs corn.

The average crop of hay of the State is 2,200 pounds. The corn will cost for labor of men and team not less than $6.00 per acre, or fourteenth of a cent for a pound of corn. The hay will not cost over $1.30 an acre or .059 of a cent a pound or only about one-seventh as much as corn in labor to secure a pound.

It is true that the two foods have not the same nutrive value, pound against pound, yet inasmuch as the clover and timothy average to contain as good or better ratio of albuminoids to carbohydrates as seen by the next table, we may assume that a pound of digestible matter of hay has practically as high a value as a pound of digestible matter in corn.

The following table will give the digestibility of corn, clover and hay. The former table given, is from American analyses. I shall apply

to it the digestion percentages found by actual trials by German experiments. I use German results in the absence of sufficient American data.

Digested per 100 pounds of following foods:

	Albuminoids.	Fats.	Carbohydrates.	Total.	Nutritive ratio.
Corn	8.36	4.70	62.90	76.96	1: 8.8
Clover	6.97	1.21	41.78	49.96	1: 6.4
Hay	4.92	1.13	48.06	54.11	1:10.3

The average nutritive ratio of a mixed fodder made up of equal parts of good hay and clover is almost identical with that of corn, while the average amount digested with this mixed fodder is 52.03 pounds per 100 pounds fed. The corn has 47.9 per cent. more digestible food per 100 pounds than these mixed hay foods. In some practical experiments made several years ago I received a little over 60 per cent. more value in grain from corn than from timothy hay. But the timothy that I fed did not have the value that the above mixed ration of hay and clover has.

From the feeders standpoint, I deem the figures above approximately correct.

If we apply these figures to the cost per pound of corn and per pound of hay we shall have as a result a pound of digestible matter in hay costing for labor .11 cents and in corn .52 cents, or the corn cost five times as much per pound of digestible matter.

In these figures I throw out the value of the fodder of corn as our farmers virtually do in practice. I have seen, however, that the whole plant of corn is poorer than good hay and, as all well know, must cost more.

We have in hay then not only our cheapest stock food but our grandest soil protector and invaluable rotation crop.

I have compared grass with corn because I recognize in corn the world's best forage and tillage crop and next to some member of the grass or clover family, its most desireable source of animal nutrition.

Personal experience, as well as theoretical data, convinces me that our beef could be made much cheaper in Missouri if we used good hay more and corn less.

THE COMPARATIVE YIELD OF GRASS.

It is customary to measure the value of the grasses by their comparative yield by the side of other crops. This method would be more rational if equal care was bestowed upon the grasses that other crops receive. It is nearly a universal custom to seed down to grass after years of exhausting tillage and the ground is "worn" as it is called. Even in sections of country where systematic manuring is resorted to exhaustive crops intervene between the manuring and the grass crop. The true merit of the grasses can only be fairly gauged when under conditions as favoring as those received by other crops against which it is put in comparison. Under such conditions it will be found that the best grasses yield surprisingly near as much as more popular crops do.

Even when grown for fodder alone in drills, as for ensilage purposes, carries the appearance of a vast disparity in yield in its favor, when compared with timothy or clover. Twenty tons is certainly a full average yield of green fodder corn per acre, as judged from the records at hand. Analyses of 36 samples of green fodder corn show but 18.92 per cent. of dry matter per 100 pounds, the balance of course being water. This is necessarily an under estimate rather than an over estimate of water. Yet this affords but 7,568 pounds of dry food per acre. Three tons of hay will easily grow on ground in condition to grow 20 tons of corn fodder. Hay carries 85 per cent. of dry matter or 3 tons 5,100 pounds of dry matter. It is common to hear the fodder corn crop estimated at 4 to 8 times as great as that of the grass crop instead of one half larger to twice as great.

THE CULTIVATION OF GRASS.

"Making a pasture sod breaks a man and breaking a pasture sod makes a man" is the substance of an English proverb. Not so with the hay grasses. They need frequent sod-breaking and fining of the ground and renewal of the seed for fresh roots and a new and full stand. This work was less important when grasses were allowed to seed before harvesting. Now no farmer who rightly values hay grasses pursues so short-sighted a policy intentionally. The result is that the vacancies caused by worms, frosts, old age and other causes are not now as formerly filled with fresh plants by natural seeding of over-ripe grasses. Timothy with its surface bulb is pre-eminently subject to death by frosts, rotting through rupture, treading, &c. Timothy may be said to be an imperfect perennial and does its best the first two or three years of its life.

After a mat of grass is formed over the ground and the soil is filled with interlacing roots, air circulation in the soil and resulting soil decomposition is impaired by its sealed up condition. We know that sod over wood admits air so slowly that it burns imperfectly and to coal; that loose manure heaps rot rapidly while close ones rot slowly; that green corn compressed keeps as in the formation of ensilage, and that stirred soil leaches more rapidly through, in part more rapid decay, as shown in Mr. Waters' article. By test from sod land there was leached out per acre, yearly, .30 lbs. solids; bare soil there was leached out per acre, yearly, 218.7 lbs. solids.

Nitrogen tends to accumulate in the soil shown in the article referred to and proven by a long list of experimenters. I will add to the evidence of Mr. Waters' paper the following from Deherain's trial:

	Nitrogen lost for 3 years; crop, corn.	Nitrogen gained next 4 years; crop esparsette.
Stable manure	808 lbs.	327 lbs.
Nitrate of soda	663 lbs.	134 lbs.
Sul. of ammonia	732 lbs.	135 lbs.
No manure	567 lbs.	149 lbs.

This accumulating nitrogen and the great mass of roots of grass can be realized upon by opening the soil to the air and stirring it. This process must not be a continuous one, otherwise great loss occurs. I strongly recommend that aged grass and enfebled grass roots be not maintained and that reseeding occur frequently, and through a rotation with other crops, two to four years being long enough for grass, and that sowing be done on fine tilth.

FINE TILTH.

A finely pulverized soil is indispensible to a quick and good grass sod. A cloddy soil is the graveyard of the young microscopic roots of our grasses. Grass seed is the smallest of all of our field crops grown in this country, and has the tiniest little root fibres. These, between the spaces of clods or coarse soil, or on lumps or turfs, meet, if perchance the seed germinates in the dry spaces or on hard clods, an early death or commence the battle of life in that stinted condition known to be so fatal to thrift in the animal kingdom.

Pulverization of soil is multiplication of soil area. Thus a lump of earth an inch cube if by dividing into lumps of 1-10 of an inch each has the surface exposed multiplied 100 times. Really, in good practice, pulverization, if theoretically perfect, would, by preventing such lumps—for it is far easier to avoid a cloddy soil than to fine such a soil—multiply the surface exposed many thousand times. Between a roughly fitted seed bed and a well fitted one there is a difference in regard to easily available root area of young plants, rarely comprehended.

It will be understood, without elaboration, that the greater the root area the more food falls within reach of the plant. Division of soil is multiplication of the farm.

FINE TILTH TO MOISTURE.

While moisture is literally plant food it has not that function in popular acceptance.

Whatever view we take of it, all agree to its vital relation to plant growth. Few, however, understand the relation of soil division to soil moisture. Moisture is held in the soil by adhesion to the surface of the particles of soil. The more particles of soil the more surface, and the more surface the more moisture held. But the soil does more than simply hold water, it keeps it by the law of capillarity in constant motion in the soil; upward awhile after a rain to meet evaporation, and downward during and immediately after rain.

Thus, Prof. S. W. Johnson found that a clay soil tested would hold a column of water 36 inches high by capillarity, while clay lumps of the size of peas would hold water but 9 to 12 inches. He also found that 14 inches of soil that would pass through the following sieves evaporated the accompanying amounts of water in 30 days:

Soil passing through 1-8-inch sieve evaporated 22.36 grains.

Soil passing through 1-25-inch sieve evaporated 28.89 grains.

Soil passing through 1-100-inch sieve evaporated 55.88 grains.

A fine soil will draw more water and from deeper areas than a coarse soil, and of course furnishes it to needy young seeds. In short, fine soils bring into immediate proximity to the young grass-seed and roots more plant food and water than a coarse soil does. I have thus partially elaborated this subject because I hold that grass seed or grass roots need more than any other of our farm crops; the application of the above truths and that special application of these facts is essential to a good or the best grass crops.

I need not detail methods of obtaining this fine tilth; summarizing them it is found that plowing the soil when in a medium degree of moisture, harrowing before drying out, with the best implements of the day, most thoroughly, finishing off with the Thomas smoothing harrow, leaving the field much like the surface of a garden, are essential factors. Thoroughness, absolute fidelity, here is a part and an inexorable part of the price of a good grass crop. The present practice is one of the weak spots of our grass farming.

MANURING FOR GRASS.

In the Eighteenth Annual Report of this Board I have considered quite fully the subject of manures and therefore will state my views of manuring for grass without elaboration.

I have tested the various manures for top dressing grass and, except possibly for moist, rough ground, have become strongly convinced that tillage, new seed and new roots are the only true methods of growing economically large grass crops. Tillage is thus accompanied by the incorporation of the fertilizer used with the ground.

With the soluble, chemical manures, I have met with fair success from their use on grass without breaking the sod. The elements of plant nutrition in the manure penetrate the earth with unequal rapidity; phosphoric acid moving very slowly down while potash penetrates faster, and nitrogen faster still. This separates these materials in a soil in a measure. The phosphoric acid has a tendency to call the roots to the surface to an abnormal and undesirable degree, hence I prefer to work it into the soil.

If top dressing of yard manure is to be applied, it should be fermented manure, brushed in by a brush harrow under the leaves of the grass.

Theoretically, each crop should be manured, but practically this is difficult to do, and I have followed the system of manuring well the tillage crop in the rotation that precedes grass. It results in a diffusion of the manure, not needed by such crop, through the soil, ready for the everywhere penetrating roots of grass.

I would prefer manuring when grass is seeded or just before, if equally as convenient.

Theoretically, the manure should be applied on the surface of the plowed ground and thoroughly incorporated into the soil by tillage implements, but practically the point is unsettled as against plowing under. (See Eighteenth Annual Report, under "Manures.")

In the modern acceptance of the term, chemical manures cover materials that we cannot afford to use in this State to grow grass.

Ashes are an exceedingly effective grass fertilizer. They are especially so for clover. The potash of ashes supplies a special need of this plant and induce a most vigorous growth. Plaster is also favorable to clover and often to timothy.

When bone meal is used with ashes a sure and handsome gain of crop is made and usually at a profit when hay is seven or eight dollars a ton. Our waste ashes will pay well for use and will pay at a moderate price per bushel.

DO NOT SELL HAY.

The great disparity between the cost of the chemical manures needed to make a ton of hay and the value of the hay, calls attention to the fact that hay is the most unfortunate crop that we can sell from the farm, taking an exceeding heavy draft of fertility from the soil for a very limited money return. The following table shows the amounts and costs at present money rates of the elements of plant food contained in a ton of timothy hay:

Nitrogen, 26 lbs. at 16 cents	$4.16
Potash, 34.2 lbs. at 4 cents	1.37
Phosphoric acid 8.2 lbs. at 8 cents	.65

Clover hay is a most emphatic illustration of the point.

Nitrogen, per ton 42.8 lbs. at 16 cents	$6.84
Potash, per ton, 39 lbs. at 4 cents	1.56
Phosphoric acid	.89
Total	$9.29

We cannot go into the market and buy the chemicals that will produce those for the sums mentioned.

Many urge that these crops grow well without manuring much. If so, it is a virtue of these crops that we should seize upon by growing more of them; but, when grown, we should feed them on the farm and make manure to grow those crops that will not thus freely grow without manure, and thereby bring them up to the point of profitable yields. The fact stands, that in selling hay, we sell fertility to a large

degree for a small sum and reduce the amount in the soil for a mere pittance—materials that our sons will certainly have to procure in some way and if at present rates at a cost of more than the present entire sale value of the hay.

VARIETIES TO SOW.

Gould in his admirable work on the grasses, states the number of distinct species at 3,000, but we learn that there are a great many more than this number. This does not cover the Pulse (clover) family which much outnumbers the grass family. A great part of this mass of plants is not recognized as hay grasses. Corn, oats, wheat, sugar cane, etc. are grasses while clover is not a grass neither in form above or within the ground, in system of growth, chemistry nor in feeding value. Among the large number of varieties that have been moulded to fit various conditions of soil, climate and special conditions it is contrary to observations and reasons to suppose that timothy, red-top and clover, (I should use clover in the relations of a grass crop or artificial hay) can fill all conditions of soil—whether sandy, clayey, gravelly, loamy or peaty, wet or dry, and all conditions of climate.

J. Stanton Gould found twenty species of grass besides clovers on one square foot of ground, and 1,700 plants, but rye, which is a grass, gave but seventy-five plants. Sir John B. Lawes found fifty species in his lawn at Rothamstead.

The grasses have different systems of root development occupying different areas of soil. They have by their varying acids of the roots in all probability, varying powers of soil decomposition for special minerals needed as food. They have unlike demands upon the elementary materials of plant growth.

Therefore, the sowing of mixed seeds secures in part, the advantages of rotation of crops and a more complete occupation of the soil, both by root development and stem growth above the soil. Such mixed grasses as shown by analyses, furnish stock with a better balanced ration or a better ratio of fat formers, (hydro carbons) and flesh makers or albuminoids and induce a better growth. This influence is very marked on some of the fine English pastures seeded down to twenty or more varieties of grasses upon which five hundred pounds of cattle growth is made per acre in six months. The discussion of cattle grasses for pastures will have to be deferred to a future occasion; but the rich results of mixture of grasses for pastures have some points of analyogy to field grasses designed to make hay for rapid growth of stock.

For permanent meadows and for meadows formed for several

years of existence, there should be no hesitation in growing a variety of grasses, mixing those that bloom approximately together.

I will quote several mixtures recommended by good authority. Mr. Crozier, (author of a farm work), also Mr. Bachelor, both of New York, are widely known as successful farmers and students of the grasses. Mr. C. L. Flint of Massachusets, author of Flint on Grasses, and Prof. Lloyd, also author of an able English work on agriculture.

CROZIER.	LLOYD.	BACHELOR.	FLINT.
Orchard Grass.	Orchard Grass.	Italian Rye Grass, 5 lbs.	Timothy.
Meadow Fox tail.	Meadow Fescue.	Meadow Fescue, 5 lbs.	Red Top.
Sheeps Fescue.	Sheeps Fescue.	Red Top, 5 lbs.	White Bent.
Rhode Island Bent.	Timothy.	Timothy, 12 lbs.	Orchard Grass.
Hard Fescue.	Tall Fescue.	Rough Stalked Meadow Grass, 3 lbs	English Rye grass.
Sweet Scented Vernal.	Meadow Fescue.	Fowl Meadow, 3 lbs	June Grass
Meadow Fescue.	Dogs Tail.	Clover, 6 lbs.	Rough Stalked Meadow.
English Rye Grass.	Rough Meadow Grass.		Fowl Meadow.
Italian Rye Grass.	Agrostis stolonifera		Meadow Fescue.
Red Top.	Fiorin.		Tall Fescue.

Such mixture would not be judicious where grass only occupies soils two years at a time as in our College farm rotation. The cost of some of these rarer grass seeds and the fact that the rarely used sorts are apt to have mixed with them old seeds whose vitality is lost, afford an objection to an elaborate mixture including grasses that require two or three years to get well rooted and in vigorous growth.

It should be said of Mr. Crozier's mixture that it was designed to form a pasture after use as a meadow, in his system of farming.

Unfortunately, we are without adequate data, in fact, we have very little data touching the grasses adapted to Missouri soil and climate. We know that in our limestone soil we have a good foundation for nutrituous grasses.

The writer has made some trials with grasses at the State farm. At present he will only suggest among the more promising grasses: meadow fescue, orchard grass, tall fescue, tall oat grass, Rhode Island bent grass, meadow foxtail, Timothy, red top. Of the several clovers tried, common red clover and Alsike clover are the most promising.

From present information, for our soil I would use Timothy, meadow fescue, orchard grass and meadow foxtail (*alopecurus pratensis* and not fox tail of our pastures), red top and possibly English rye grass and in about the order of preference as named. It is true that they will not ripen together. This I do not attach the importance to that some do, orchard grass and meadow foxtail ripen first and both afford a fine basis for a good second crop. By the system of rotation pursued by me two crops are fully expected.

ANALYSIS.

	Albuminoids	Fats.	Carbo hydrates	Fibre.	Ash.
Timothy	8.35	3.20	56.62	18.75	8.35
Meadow fescue	10.50	3.05	46.70	25.53	6.62
Orchard grass	9.91	3.33	52.44	23.08	6.95
Meadow foxtail	9.98	3.10	50.12	21.95	7.15
Red top	10.50	3.30	53.02	20.40	6.10
English rye grass	8.38	2.68	60.39	17.25	5.75
Red clover	11.44	2.02	39.87	26.69	5.33

In chemical composition, Timothy does not show to advantage in the important albuminoids. In fibre it is, in the above sample, less rich than the others. These analyses were made at the Department of Agriculture, Washington, and mostly by Dr. Collier. This sample of timothy is an accidental one as regards fibre, as an average of 32 samples makes it 30.35 per cent. fibre. Its great popularity seems to rest upon its adaptability to a wide range of soil, palatableness and yield.

Meadow fescue started earlier, yielded as well, stood up well, is liked by stock, analyzes better and ripened earlier than Timothy. I regard it as very promising for our soil.

Orchard grass has had considerable trial in our State, as ascertained by a circular sent out by this office, and is favorably reported upon. As a rule, many prefer it to timothy. This favorable view, I question, but deem it worthy of trial. It starts early and ripens by the first week of June.

Meadow foxtail grows very early and ripened first of all the grasses named. It was largely headed by May 1st. After ripening it remained green, save the heads, throughout until the other grasses ripened. It has the reputation of a fondness for wet soils and moderate yields. It did finely on our upland clay loam soil with a moderate rainfall and gave a good yield of leafy grass.

English rye grass was the first green grass of the lot, but did not grow so rapidly as others and lodged badly. It gave a fine yield of bright hay. Sown with other grasses to hold it up it may do better, and has done better than when sown alone. It ripened early in June.

CLOVER.

Clover was omitted in the mixture named. I sow it alone, cutting it but one year and in two crops. This method serves several indispensible purposes to me. One of the incidental ones is that it increases the length of haying and allows the cutting of the meadows at the right time. This object would be aided by sowing Timothy, meadow fescue and red top together, and for earlier cutting orchard and meadow foxtail grasses together. This method would much extend the period of haying and allow of the securing of the hay at the right time without hurrying.

I regard clover as one of the most important if not the most important crop to our agriculture grown in the State. It can serve its purposes best as a separate crop in a rotation series. Its necessity with the grasses is not apparent. It is not like them, does not ripen with them, the first year it occupies the whole ground to the exclusion of the other grasses and to their injury, and at the end of the second year dies, as it is a bi-ennial plant running its course of life in two years. It is not so observed by our farmers because they allow it to seed and restock the ground—a bad practice.

Clover has an unusual mass of roots phenomenally rich in nitrogen. These furnish its store of nitrogen to wheat following their stubble, as no other approximates doing that is grown by us. Wheat is such an impotent crop to secure nitrogen that it deserves the good offices of clover for this purpose. This can well be only as it is sown alone.

The nitrogen thus stored in the roots often equals 180 pounds or enough for 110 bushels of wheat.

Clover also fills a place in feeding that no other crop can as economically. This function I have presented in the Seventeenth Report of this Board to your Honorable Body.

As a soil renovator, as a source of cheap and abundant food per acre, and as a cheap adjuster of the nutritive ratio of stock rations it is peerless. Please note its analysis for large content of albuminoids. The philosophy of its merits would require a special article, and I therefore confine myself to asserting its merits in general terms and of claiming for it a distinct place in our farm rotation.

Probably no crop has had so little effort bestowed upon its improvement as the hay crop. Pacy stands alone in his efforts which were confined to the selection of good seeds of rye grass.

From a weight of 16 pounds to 18 pounds per bushel he brought the seeds of this grass up to 24 pounds to 30 pounds net per bushel.

The grasses cross without much difficulty, yet doubtless great results await him who first creates a new and more desirable variety by cross fertilization or bybridization. It is astonishing that this universal crop, that largely determines the value or cost of beef, mutton, wool and milk, should have been so completely neglected when thousands of varieties of potatoes and other foods have been made by artificial means.

Passing through the fields great variation in size of head, amount of leaf surface, size of stem, strength of stem, general appearance as to vigor, etc., will be noticed. Prof. Beal, who has given us a valuable treatise on grasses, mentions many diverse forms of clover. These can be fixed by selection as can the better grass types. Why cannot a more leafy Timothy be developed?

AMOUNT OF SEED TO USE.

The systematic use of grass seed has not been a continuous one for past ages. At the opening of last century but little grass seed was sown in England, and that sown was confined substantially to the sowing of chaff from haystacks and places where the overripe hay shattered its seed. With the growth of wealth and the greater consumption of meat there has followed more attention to the grasses.

The ancients, even the Romans with their high type of agricultural methods, outside of natural pastures used only the annual grasses like millet to a limited extent. The press of population in countries like India and China tend to restrict ruminating domestic animals. We in this State use three to four acres of ground to keep a steer that may grow 400 pounds, or 100 pounds per acre. Of this 60 pounds are dressed carcass. Of this 60 pounds 46.14 pounds are bone and water. Thus we get from an acre of ground by stock approximately 13.76 pounds of dry organic matter. An acre in wheat will produce 1,600 pounds of dry organic matter or 116 times as much as in the form of beef, while corn will produce nearly twice as much. Dense populations tend to restrict the area in grasses, while when the pressure of population makes it necessary to put it to the test, very dense settlements are possible on the basis of vegetable diets.

It is said that clover was not sown in England until the middle of last century, and in Scotland the last of the century or 1792.

Returning to the subject matter of the heading I shall note several factors that militate against definite data here.

I. Age of seed. Our dealers mix the remaining old years stock with the new to a large extent. This is especially true of rare sorts. To this trouble adulteration is added, supplemented by weed seeds.

For the purpose of selection, to obviate the introduction of weeds and to secure fresh seed it is better to grow our own seed when at all convenient, and thus give more assurance to the results of our seed sowing.

II. The degree of fertility and the fineness of the soil are strong determining causes.

In every case, for several trials of methods of applying manure, I have thought from the appearance of the young grass that twice the number of seeds germinated on suface manured ground than grew on ground where the manure was plowed under and beyond the reach for nourishment of the young roots.

Many progressive farmers have advocated from one-half to one bushel of Timothy per acre. These amounts would be needed on poor, lumpy soils but by no means is so much needed on good soils. It is said that the thicker the grass the finer the stem. But this involves a densely covered soil, the more complete interception of the sun's rays and more succulent and less palatable hay.

The richer and the finer the pulverization of the soil the less the seed required. I use 12 lbs of clover seed and 12 qts. of Timothy per acre. This gives of Timothy 52 seeds per square inch. If one-half live it will be a heavy seeding.

Many seeds are destroyed by too deep covering. J. J. Thomas found that at one inch deep all the seeds of Timothy died. Sown after the Thomas harrow has levelled the ground and then brushed in with the brush harrow, they will be found well placed. It is generally overlooked that the size of a seed is an approximate measure of the relative depth that it should be covered, especially in relation to grass seed, and thus multitudes are destroyed or impaired in vigor, the nourishment of the seed being exhausted before the leaves open to the air and supply plant food through their action. Indeed the leaves must act before soil or air food is elaborated.

Henderson makes the weight of seed per bushel as follows:

Timothy, 45 lbs., and said to have 50,000,000 seeds or 8 to square inch per acre.

Clover 64 pounds.

Red top, 12 lbs., sow if alone 1 to 2 bushels.

Perennial rye grass, 12 lbs., sow alone 25 to 30 lbs.

Meadow foxtail, 5 lbs., sow alone 2 or 3 bushels.

Tall oat grass, 7 lbs., sow alone 2 to 3 bushels.

Orchard grass, 15 lbs., sow a bushel or more.

Alsike clover, 60 lbs., sow 4 lbs. seed.

Alfalfa, 60 lbs., sow 25 lbs. according to Crozier (heavy).

WHEN SOW.

After a varied experience I have returned to seeding with grain crops.

Sow alone, urge many, and not force the tiny grass seed into conflict with the gross feeding and vigorous growing annuals. But sowing in the spring alone forces the grass into conflict with rank annual weeds with the result of a fine crop of weed seeds, if the weeds are not cut off before blooming, and a moderate crop of grass.

The perennial grasses grow slow and there is a loss of the full effect of the soil the first year when grass seed is sown alone in the spring. Sown in the fall a risk of winter-killing occurs unless sown early, in which case late summer droughts affect it.

Sown with grain on a rich soil in fine tilth, I find that grass roots leisurely the first year and gives a good crop the second year, free of weeds in good farming. The pro and cons of this seeding question are too full to trace out. I have sown by most methods that have been in vogue and find less objections to seeding with grain than by other methods. This seeding with grain may be with oats in the spring (oats are a hard crop to seed grass with) or with wheat in the fall. By some means grass does better when seeded with wheat than when seeded with oats. I seldom have trouble with grass sown with oats when early done on a good soil.

WHEN HARVEST.

Said the great Roman writer, Pliny: "There is nothing worse to a meadow than to suffer grass to go to seed." "The fit time to mow down grass is when the spike or head thereof beginneth once to shed flowers and wax stiff." Cato, the famous Roman censor and rural writer, said: "Down with your meadows before the seed of your grass be ripe." Pity that we are not up in practice with these enunciations of nearly 2,000 years ago.

A generation ago European and American counsel was to cut when the flower begins to fade. Their practice was not as good as their standard. The progressive farmers of the country advise cutting during the flowering period while radical dairymen have advocated cutting grass at heading or even, but rarely, before heading.

The views of farmers in this State are conflicting, each extreme being represented. The average practice is bad, allowing a heavy ratio our grass to go to seed before cutting. The extreme views of some

parts of the country in favor of early cutting do not prevail here to a material degree.

WHY CUT HAY AT OR BEFORE BLOOM.

The advocates of early cutting have had the almost universal support of scientists (botanists and agri ultural chemists). The reasoning has been that growth practically ceases at bloom and that after that date the value of grass is decreased by the starch, sugar and gum of the stem either being converted into woody fibre or moving forward to form seed. This woody fibre has been held to be indigestible in the stomach of animals.

The advocates of the above views held that more actual nutrition is obtained per acre when grass is in bloom than at any subsequent period in its growth.

These views I carried into practice on my own farm, cutting from 200 to 300 acres of grass. Subsequently, four successive years of experiment work of a very careful nature, led me to publish bulletins calling in question this popular opinion of progressive farmers. These results, covering many acres of carefully staked, long and narrow strips of grass, have shown that from bloom to seed formation is a period of very rapid and of a very large growth. As an illustration, when timothy was one-fourth in bloom the yield was 2,768 lbs. per acre of dried timothy and 3,538 lbs. 10 days later, when out of bloom. A German trial with the oat crop, which is a grass, gave as follows:

	Water in plant.	Dry matter in plant.
Cut before bloom	5,074 lbs.	1,284 lbs.
Cut in bloom	12,240 lbs.	4,383 lbs.
Cut after bloom	9,556 lbs.	5,427 lbs.
Cut when ripe	3,736 lbs.	6,886 lbs.

The apparent decrease of the weight of a crop after bloom is that of actual decrease of water and occurs during an increase of food matter. I might multiply recent evidence from other experiments and in various directions, of the growth of a crop subsequent to bloom. The fact of such a growth is now certain and need not be enlarged upon. This growth varies with the plant, being small with some crops. I

found that the growth of clover is very much less than Timothy after bloom.

During the four years of my trials the grasses weighed from the field were fed by daily weights to steers and cows in accurate trials, wherein steers and cows and milk and butter were weighed.

One brief trial out of many may be cited in feeding two-year-old steers. Nothing but hay was fed:

Lot 1. Fed hay cut in bloom; ate 1,344 lbs. in 35 days; gain 29 lbs.

Lot 2. Fed hay cut after bloom; ate 1,359 lbs. in 35 days; gain, 77 lbs.

Change of food to eliminate any error from one lot of steers being better than another:

Lot 1. Fed hay cut after bloom; ate 1,285 lbs. next 35 days; gain, 19 lbs.

Lot 2. Fed hay cut in bloom; ate 1,454 lbs. next 35 days; gain, 61 lbs.

Total gain from 2,798 lbs. hay cut in bloom, 90 lbs.

Total gain from 2,644 lbs. hay cut after bloom, 96 lbs.

This practically similar gain is made from 154 lbs. less hay cut after bloom than that cut in bloom. This result is above the average difference noted by me. The experiment reveals a reason why so many misjudge in favor of early cut hay. The superior palatableness of the early cut hay led those animals receiving it after the change to eat more and of course to gain more; or, it were more truthfully stated, that the change from a palatable to an unpalatable food resulted in those changing to the unpalatable food to eat less. This disposition to reject less palatable food after a change of foods is held by cattle for many days and even to two or three weeks. During the first period of feeding the steers were taken from other food, all being fed alike in this preliminary period, thus, as regards kind of hay, they had no prejudices to overcome, hence ate alike. Those farmers who are sure early cut hay is best, feed the early cut hay and then change to the late, get less eaten of the late cut hay and less gain, of course, and prematurely conclude that hay cut after bloom is not so valuable as that cut in bloom.

These trials, made six to ten years ago, have had slow if any acceptance, as they conflicted with supposed science and farmers observation of the progressive type. I have in my desk a trial by a well known and competent experimenter, who repeated the trial given by me with like results. This he never published but privately furnished me with it.

Recently the Maine Experiment Station has published results confirmatory of mine. We may now assume with safety that the grounds thus taken by my first bulletins are entitled to more serious consideration than heretofore accorded them.

RELATION OF SCIENCE TO THE PERIOD OF CUTTING.

The position of chemistry that albuminoids decrease and fibre increases in the maturing plant and that the plant is less digestible, seems to be true. The following illustrations as a sample shows the data upon which such conclusion is based:

My timothy, before alluded to, in bloom contained 6.56 per cent. of albuminoids, and 26.95 per cent. of fibre, while out of bloom it contained but 5.63 per cent. of albuminoids and 29.09 per cent. of fibre. So far as the albuminoids are concerned on the above basis the yield per acre of the early cut was 181.58 lbs. albuminoids, while that cut out of bloom was 199.18 lbs. But a trial by Kuhn shows for clover that in bloom 65 per cent. should be digestible while but 59 is digestible out of bloom, of the albuminoids. Applying these figures we get of digestible albuminoids, with the former 118 lbs. and with the latter 117.58 lbs. Do these figures justify the assertion that hay cut in bloom is of the same value as hay cut just after bloom? By no means, although it has been practically so assumed.

This view has grown out of the vastly exaggerated views of the relative value of albuminoids to carbohydrates. The decrease of albuminoids is accompanied with an increase of other materials. (See analyses of the Timothy above.)

	Cut July 1st.	Cut July 11th.
Albuminoids	6.56 per cent.	5.63 per cent.
Fibre	26.95 per cent.	29.09 per cent.
Carbohydrates	51.07 per cent.	49.90 per cent.

But it is said that the increase of fibre is indigestible. The following trial by Germans shows that steers do digest fibre:

	Digested of fibre.	Digested of carbohydrat's.
From clover	41	69
From hay	63	63
From oat straw	59	44
From wheat straw	52	40

From hay and straw the fibre is as digestible, according to these results, as the carbohydrates. Recent results seem to show that fibre is not as digestible as those found by the Germans. The point is not well settled. Trials show that late cut Timothy is much more digestible than late cut clover as to its albuminoids, but critics have been basing their conclusions on clover. I gave the results at the worst form in which it is usually stated.

On the reverse side of this question and in conformity to more recent discoveries we have the following favoring views regarding hay cut after bloom:

I. Hay cut in bloom has not all of its nitrogen formed into albuminoids, as heretofore assumed. This process of albuminoid formation from non-assimilable nitrogen compounds probably goes on to seed formation. In root crops 30 to 79 per cent. of the nitrogen is non-albuminoid nitrogen. Armsby found this ratio in hay to vary from 8.93 to 38.83 per cent. The early cut Timothy in my trial was 18.50 per cent. and the late cut only 9.4 per cent. non-albuminoid nitrogen.

Collier and others have shown that the carbohydrates are undergoing change from bloom to seeding. The sucrose increases while the glucose decreases. There is a constant change in other matters after bloom, even the minerals undergo changes in form and place.

Chemistry cannot measure the value of these changes. The presumption is all in favor of this organizing process being towards more valuable forms. We know surely that some of the changes are in this direction. The mere change of materials from stem to seed instead of indicating retrogression in value direct to the reverse process, if to any direction, as the seed is very digestible.

The digestibility of the carbo-hydrates in the maturing process is scarcely changed. The total amount of these nutrients is for the timothy crop, fibre being included as it is a carbo-hydrate, for the early cut timothy 2,156 pounds for that cut after bloom 2,704 pounds. This gain of 546 pounds of carbo-hydrates has been too lightly overlooked. While the transitions of the complex materials of the plant from one

form to another in ripening have not been understood, or rather not known, until recent years and are not now understood. Glucose decreases while sucrose increases. The wax, fats, etc., change. It is known that in the movement through the cell membranes to the point of assimilation in growth, nutrients are in a soluble state and not chemically the same as they are when finally stored in growth.

The property of elaboration of inorganic materials into organic is that of plants and not of animals. These transition compounds are less and less as the plant progresses up to a certain variable point.

DIGESTION NOT ASSIMIMILATION.

The demonstration that a large per cent. is digested from early cut hay cannot prove that it is more valuable. Different materials are digested in the one case than are digested in the other, as shown. It is the amount of the kind of materials needed and that may be assimilated that concern us. These, I assert, are greater in hay just after bloom than in hay cut in bloom, basing my assertion on the trial related.

NOT LATE CUT.

This argument is not for the shiftless farmer who cuts after seeding, nor for those who hold to the right period and use the wrong one, as do a large share of our people. Delay in cutting is in the interest of poverty, a wrong to ones family robbing them of the means for adornment, rest and culture. "Better two days too early than two too late."

Never allow the seed to mature. Which one of us would wait until corn was ripe, if corn had the habit of shattering its seed, before cutting up and then secure the stalk. We throw the stalk away in our present practice.

He who waits for his seed to ripen before mowing throws away the most concentrated part of the plant and takes the husk, as it were.

I do not know when to cut as closely as I would like to, but from a mass of comparative data from corn, oats, wheat, etc., and from direct tests of hay, believe that at about the time the seed passes out of the dough state it is richest and heaviest. It should be cut about the time the seeds form in order to obviate their shattering in curing and passing through the animal whole. I now speak of Timothy. Orchard and some other grasses it is believed should be cut earlier.

For butter production, I should be tempted to cut earlier, as a better color and aroma will be given it, but not a greater amount of butter will be received. Its greater palatableness and softness commend its early cutting for young things.

Clover should be cut when the heads are browned. The shattering of the leaves that follows later cutting robs clover of its glory—its rich leaves.

The relation of early cutting to succeeding crops is a matter of dispute and not a matter of recorded tests. The storing of the bulb of timothy with its stock of food for spring use will be more perfect after bloom, doubtless, and leave it in greater vigor.

The relation of cutting to the soil fertility is often a matter of inquiry. It is not a material question as succeeding growth is mainly from air and water, yet not wholly. For crops that I feed out, I care little how exhaustive they are, provided a good system of saving manure is at command.

CURING HAY.

Grass cut after the dew is off and drawn in during the heat of the day represents conditions desirable in harvesting. These conditions are not always practicable. The Eureka mower leaves the grass in a most admirable condition to dry evenly as its semi-erect condition allows the sun to penetrate the mass. To obviate the over-drying of the surface of the fallen grass while the underside remains moist and green, the hay tedder has come into use to supplant the tedious hand process of turning the hay. When the surface of the grass has dried partially the tedder will shake it up loose and in part invert it, leaving it in a mechanical condition through which the suns rays readily penetrate and the moisture freely passes off.

Where hay yields over one ton to the acre the tedder is needed, and this need is in proportion as the yield exceeds the amount named.

The time required in properly drying hay will depend upon whether it is stirred and its degree of maturity.

MODERATE DRYING DESIRABLE.

The old and persistent view that green food is worth more than the same food in the dry state has had a radical expression in the extreme views held regarding the superiority of ensilage to dry food and the rapid multiplication of silos in this country for the past seven years.

Direct tests have shown that very rapid and severe drying may be injurious to hay, but that favorable curing does not injure foods. Drying is but the evaporation of pure water, having no more nutrutive value than well water if drying is properly carried forward.

A test in Germany of dried hay against similar hay in the green state gave results as follows:

DIGESTED OF ONE HUNDRED POUNDS.

	Protein.	Fibre.	Carbo-hydrates.
Green food	79	33	68
Dry food	78	34	65

These results have been regarded as virtually identical. The loss that seems to occur in drying is affirmed to be that of the rich, tender leaves lost in handling dry foood.

Professors Cook, of New Jersey, and Henry, of Wisconsin, have found that dry corn fodder gave as good results as the same food in the form of ensilage. Prof. Henry's results were as follows:

16.11 lbs. of dry matter in corn fodder made one pound of butter.

15.69 lbs. of dry matter in ensilage made one pound of butter.

The former result was from consumption of enough more food to about balance the difference in results.

I have fed green foods against dry foods for years, and have found no results that indicated that green food is more valuable than dry food.

The necessity of housing food in the very green state does not exist, yet over-drying is accompanied by loss of the leaves—the best part—and when badly done, of nutrition. Moderate drying avoids some risk of wet weather. Dr. Brimmer has shown that clover rained upon lost 7 per cent. of albuminoids and 7.1 per cent. of carbo-hydrates. These materials represent the soluble and best parts of the plant, those that peculiarly make a fodder palatable.

From Dr. Armsby's valuable work on stock feeding I have drawn a table representing the influence of badly drying hay:

	Composition.		Digestibility.	
	Dried with no loss.	Dried with loss.	Dried with loss.	Dried with no loss.
Protein	17.00	14.94	71 per cent.	67 per cent.
Fibre	31.81	33.90	48 " "	45 " "
Carbohydrates—Fat	43.80	44.22	66 " "	62 " "
Ash	7.39	6.94	29 " "	23 " "

The method advocated by those who are generally regarded as advanced thinkers, to avoid this loss is to mow after the dew is off, use the tedder before noon, and often directly after noon and draw at once to the barn, even in the early period of cutting hay. All hay drawn is put into one mow and trod very compactly. The old method was to put green food or underdried hay in scattered amounts. The former method is the better, as it secures a greater exclusion of air, the cause of heating when in conjunction with the moisture of the hay is freely accessible to stored foods. Success has thus been obtained. The cost, is even spreading of the hay and thorough tramping, all going into one body at the day of stacking or storing. Most parties trying the system have failed from non-compliance with its condition.

Timothy cut at visible seed formation, in good weather, tedder being used, may be drawn the same day. Otherwise, this crop and clover may be heaped at night and opened and turned the next day.

Clover needs special care in drying, otherwise its value is very heavily reduced by the loss of over dried leaves that easily break from the stem. I have seen the ground literally covered with the leaves of badly dried clover.

The tedder can never be justifiably used on clover after the leaves dry so as to break from their stems. At this stage it should go into heaps where the leaves will absorb the moisture from the stems and thus dry them and again toughen the leaves so as to bear opening and drying. Some allow the clover to "sweat," as it is called, in the heap and then open or as is often done set the heap over a forkful at a time, making a new heap with top and bottom reversed. I do not look with especial favor upon the sweating process as it occurs through heating and the heating occurs at the expense of the fodder, but recommend the slow process of partially drying clover in heaps or drying in greater mass than it would be in when spread out in the field. While it will cost some more it will be worth more. Being both more palata-

ble and more nutritious it will result in greater consumption by stock and more growth. The one may make no growth, the other a good steady winter growth.

In view of the facts given and other and minor considerations, the following is believed to be advisable: Avoid excessive drying, rains and dews. Very green hay is not essential to full feeding value, and as green hay is hard to handle and needs care in storing, it is better, if necessary, to bunch hay over night and open moderately and turn, thereby saving dews, loss of leaves and excessive dryness.

By the use of the tedder, hay cut at the period advocated in this paper may be put into the barn the day mown, unless for very heavy yields of say two to three tons per acre.

STORING HAY.

In bulletin 25, I have shown that stacked clover lost 13.7 per cent. of its original matter in the stack. In experiments with early and later cut hay, I found a shrinkage of from 17 to 23 per cent. in the barn. In this case I did not ascertain whether the loss was moisture or dry matter, but certain it was largely water.

German trials have made it probable that there is loss of dry matter in stored hay. If further investigation finds a material loss in this direction it will be a strong argument in favor of the silo or of compacting hay in the barn as done by the advocates of half dried hay.

Dr. Armsby quotes foreign trials touching the digestibility of stored hay in the fall and again in the spring.

	Digestibility.
At the time of cutting	62 per cent.
Three months after cutting	56 per cent.
In spring	54 per cent.

Possibly the result may be due to the impared digestive capacity of animals in the winter and spring, but it is not probable that the whole difference occurs at this point. The matter is not a definite demonstration as yet.

I stored weighed corn fodder where air circulated over and under it, and gave a startling shrinkage that certainly involved the substance of the fodder heavily. 2,071 pounds weighed in the winter 1,080 and 1,977 came out 1,140 pounds.

It is quite probable that hay should be massed and in as compact form as practicably possible.

The question of housing hay was presented in the last annual report.

The arguments there made need not be repeated. The loss of hay from washing rains, moulding, tramping out, &c., will pay a high rate of interest on good shelter. With hay loaders and hay unloaders the cost of housing is not now severe nor laborous.

The value of salt and lime in preserving hay is often debated. The process is of questionable value. The use of lime is more than doubtful, while an excess of salt induces thirstiness in stock. This leads to excessive water drinking and an increased consumption of food to warm the water, to vaporize some of it and to excrete the balance. Too much salt has been found to be undesirable.

CARE OF MEADOWS.

Many questions of interest occur that cannot be considered. The endurance of the mowing machine and the yield of the land are blended to some extent with the smoothness with which the ground is laid down to grass. The presence of stock upon our field after harvest is antagonistic to this necessary smoothness of surface. Each foot mark on a moist day makes a depression around the hoof and raises the ground up around the hoof into a little circular ridge surrounding the depression. This jars the mowing machine, it is cut by it dulling the cutting sections. Drought affects its elevated section while frost destroys the roots of grass in it.

Cattle should not graze meadows. They tramp out the timothy by injuring its bulb. They raise this bulb, so shallow in the ground, in the action of biting and bare the surface to the full action of frosts. If more than enough grass grows to form the proper mulch for winter protection and for holding the soil in good physical condition, it is far better to cut it than to graze it, especially for a young meadow.

The practice advocated in this paper removes the grass before seeding and makes it desirable that the meadows receive grass seed upon spots that may have been winter killed, or that have been destroyed by worms or other causes.

Seed sown upon the ground in the spring or fall will be let into it by the alternate freezings and thawings which open and close millions of shallow mouths per acre.

This paper has been some what hurriedly prepared and will fill my expectation if in conjunction with that of Mr. Waters', it aids in a

small degree to induce more thoughtfulness regarding its growth and care and encourages the more rapid extension of the area devoted to it.

The coming generation will see its present per cent. of land in tillage crops increase very much. This growth of area devoted to grasses will be accompanied by an ever increasing average production of tillage crops. To such an extent may the increase of meadow area deepen the average product of tillage crops that no diminution of the total amount of those crops raised need follow.

Solon Robinson said that no country ever advanced to the highest grade of civilization but what advanced over a grass soil. There is a strong element of truth in this assertion that should arrest our attention.

J. W. SANBORN, Secretary.

MEETING OF THE EXECUTIVE COMMITTEE.

COLUMBIA, MO, March 23, 1887.

A meeting of the executive committee of the State Board of Agriculture was held at Columbia, March 23, 1887, with the following members present:

Mr. J. A. Potts, President.

Mr. Abiel Leonard, Vice-President.

Mr. F. W. Smith.

Prof. J. W. Sanborn, Secretary.

The object of the meeting was to consider the appropriation to the Agricultural College put in the hands of the Board. After a general discussion of the plans the Dean of the Agricultural College was authorized to prepare plans and specifications of barns, houses and other buildings, provided for under the act appropriating the money, and to submit the same to a subsequent meeting of the board.

Moved, that the Dean employ the services of Messrs. Kirchner & Kirchner of St. Louis, if thought best in preparing drawing of house and barn, similar to the plans submitted to the executive committee. Carried.

Moved, that the Dean be instructed to advertise for bids as required by the law giving the money. Carried.

Moved, that the area for corn premiums be limited to five acres. Carried.

Adjourned *sine die*.

J. W. SANBORN,
Secretary.

PROCEEDINGS OF THE STATE BOARD OF AGRICULTURE.

AGRICULTURAL COLLEGE ROOMS,
COLUMBIA, MO., April 29, 1887.

The Chairman, Mr. Potts, called the house to order and announced readiness for business, which was to open bids and let contracts according to the provisions of Senate bill No. 95, appropriating money for purposes specified therein.

Secretary Sanborn read a communication from the Treasurer, Prof. S. M. Tracy, in regard to an increase in his salary.

Chairman: What do you wish to do with this communication?

Mr. Doud: Mr. President, I move to lay the matter on the table.

Mr. Smith: I second the motion.

The question was put to the house and carried.

Mr. Doud: I will read the law that appropriates, as amended:

"Amendment No. 1. Amend section one (1) of Senate bill No. 95, entitled 'An act appropriating money to properly equip the State Agricultural College and Farm of Missouri,' by striking out all the words and figures after the words, 'for,' in the sixth line of said section, and by inserting the following words and figures in lieu thereof: 'for sheds, tool-house and hog barn, the sum of one thousand dollars; for cattle and sheep barns, the sum of five thousand dollars; for dairy house, ice house and repairs, the sum of two thousand dollars; for two cottage houses for laborers, the sum of twelve hundred dollars; for the purchase of sheep for experimental purposes, the sum of five hundred dollars; for the purchase of swine, the sum of two hundred and fifty dollars; for the purchase of pure bred cattle of various breeds, the sum of three housand five hundred dollars; for the purchase of horses, carts and tools, the sum of two thousand dollars; for experimental work for two years, the sum of two thousand dollars; for student labor, the sum of one thousand dollars; for horticultural building, the sum of thirteen hundred dollars; for veterinarian's laboratory and apparatus, the sum of five thousand dollars."

"Amendment No. 2. Amend by striking out all of section two and inserting in lieu thereof the following: 'The money hereby appropriated in section one shall be paid to the treasurer of the State Board of Agriculture, who shall execute a good and sufficient bond therefor under the order of said board, and shall be expended by the Dean of the Agricultural College in the following manner: The Dean of the Agricultural College shall advertise for bids for all of the items enumerated in section one, in at least two daily papers and four agricultural papers; said papers to be published within the State of Missouri, and all bids to supply the State with any of the items enumerated in section one shall be sealed and addressed to the Dean of the Agricultural College, at Columbia, Boone county, Missouri, and upon receipt of said bids the Dean of the Agricultural College shall notify the President of the State Board of Agriculture, who shall immediately call a special meeting of the State Board of Agriculture for the purpose of opening all bids offered: and each item, as enumerated in section one, shall be considered separately, and each and every bid shall be subject to acceptance or rejection: *Provided,* that no bid shall be accepted without a majority of all the members of the Board of Agriculture shall vote to accept said bid; and the money appropriated by this act shall be paid out upon written vouchers signed by the President and Secretary of the State Board of Agriculture."

Now, Mr. President, I have counselled some of the best counsel in the State, and these men have told me that the moment we accept these bids, it is out of the power of the Board to control the spending of that money—that the moment we accept these bids, all our authority passes away from us.

Mr. Leonard: I do not understand thel aw to be that; my understanding is, that this money has been appropriated, and it is the business of the State Board of Agriculture to spend it right.

Mr. Coleman: You cannot pass any power out of the Board. If we have power to make and let a contract, is it not true that the same power has a right to accept or reject the work when complete? This is true of any private business or any other kind of business. I leave it to the Board, if it has the right to let a contract to do the work, has it not the right to either receive or reject the work when done—has it not the power? I think that is the law itself.

Mr. Doud: We must conform to certain specifications and rules relating to that money, or else certain irregularities will throw us out. This matter has been explained to me by men that fully understand it, and they say this Board has full power to control these things.

Mr. Coleman: Well, I want to see what your point is; I understand that any corporate body that has power to do a certain work, has no authority to give it up.

Mr. Doud: The State Board of Agriculture, in the law of fact, is not delegated to spend this money; the Dean shall expend this money according to the law, and the law goes on to say, how he shall spend it—in such way as shall be approved by the board.

Mr. Leonard: I cannot see the point in all this talk. When you say the Dean must spend the money, and according to what the Board says, I think the Board has authority in it.

Mr. Coleman: I would like to say it is impossible for this Board to meet every day, and if the Legislature saw fit to place it in the hands of the Dean, what right have we to say he has not charge of the matter.

Mr. Smith: Mr. Doud said the moment we accept the bids, the Board was through; I would like to know how we shall build the houses without accepting some of the bids?

Mr. Doud: Mr. Coleman has met the objection by saying the Board cannot meet every day. If a committee be appointed, it is to be supposed that the committee can give the matter its personal attention, and thus the Board does not accept the bids until after the money is expended.

Mr. Leonard: For my own information, and in order to understand, Mr. President, I would like to ask a question: Supposing a bill had been received for the expenditure of the money, into whose hands does it fall? I want to understand things as we go along.

Mr. Coleman: It falls into the hands of the contractors, and the Dean is superintendent.

Mr. Leonard: I believe I would support a resolution looking to the appointment of a committee, if we have no such committee, to assist in the work.

Mr. Doud: This gentleman who is Dean of the Agricultural College, comes here and asks to have the whole thing turned over to him. Now if this board wants to turn the matter over to him they can, but I can not and will not.

Mr. Coleman: I don't understand that this Board has the right to turn the matter over. I understand they have the right to let the contracts; the Dean holds the money, but the board has a right to approve or disapprove his actions. I think all of this is out of order, and move to lay the resolution on the table.

Dr. Laws: I second it.

Mr. Doud: I would like to have the vote taken by ayes and noes.

Prof. Sanborn: The gentleman's remarks seem so utterly out of place that I feel that there is no occasion for me to reply and deny.

Mr. Coleman: I think it would be well for you to state the object of the meeting.

Chair: I will state briefly what I understand the object of this meeting to be. The law requires that we shall advertise for bids in a certain way, which has been done by Prof. Sanborn as the law requires. He notified the President of the bids, and the President notified the members that he would call them together to open the bids sent here for the construction of the buildings on the farm. It is now our duty to examine these bids and accept or reject them, as the case may be, as we may determine.

Dr. Laws: I move that we proceed at once to the several items. I propose we take up the horticultural barn and consider the bid on it.

Mr. Doud: I move that we vote by ayes and noes.

A vote being taken, the motion passed without opposition.

Dr. Laws: The item we have before us is the horticultural barn, for which the law appropriates $1,300, and there is $5,000, appropriated for the veterinary laboratory. (Reads the Statutes.) Dr. Paquin and Prof. Taft have concocted an exceedingly ingenious plan whereby the horticultural barn and veterinary laboratory can be combined in the same building very much to the advantage of both departments, and at very much less expense, Taking the $1,300 and $1,000 from the $5,000 you have $2,300, and Dr. Paquin suggests that we take out this $1,000 and make the $2,300.

Dr. Laws: I move that the Dean of the Agricultural College be directed to proceed to have a combination building erected on the horticultural grounds for the accommodation of the horticultural depart ment, and for the veterinary laboratory at a cost not over twenty-four hundred dollars, in accordance with the plans submitted for the same. Thirteen hundred dollars being set apart from the appropriation for the horticultural department, and eleven hundred from the $5,000 appropriated for the veterinary laboratory and apparatus.

The roll call gave a unanimous vote in favor of the motion.

Dr. Laws: I will make a motion that Dr. Paquin, associated with the Dean, proceed at once to procure within the limit of the $3,900 remaining out of the $5,000 appropriated for the veterinary laboratory and apparatus, the best apparatus and appliances practicable for the use of said laboratory; the articles purchased with bills for the same to be submitted to the board for approval, and upon the approval thereof the money shall be paid therefor as provided by law.

Mr. Doud: I want to second the motion.

Chair: Gentlemen, you have heard the motion; all who are in favor of it say aye. Chair, aye; Dr. Laws, aye; Mr. Coleman, aye; Mr. Leonard, aye; Mr. Fulbright, aye; Mr. Doud, aye; Mr. Smith, aye; Mr. Sanborn, aye.

Chair: The motion is carried.

Mr. Doud: I want to make a motion. It is known that Colorado is quarantined against us. Mr. President, I move you sir that Mr. F. W. Smith and Mr. Leonard be appointed a committee to wait upon the Governor and ask that he incorporate in his supplemental proclamation the provision for such agricultural legislation as will pass a law for the protection of the live stock interest of the State, and give us power to quarantine against other States when dangerous and infectious diseases exist.

The motion was seconded by Prof. Sanborn, and was put to the house and carried.

Chair: You have heard the motion as made by Mr. Doud, and seconded, that we accept the bid of Mr. Sexton for cottage houses on condition of a satisfactory bond being given.

Carried by a unanimous vote.

Prof. Sanborn: The next smallest job is the addition to the house.

Dr. Laws: How near does that come to the money appropriated?

Prof. Sanborn: A little over; I think it can be built for $2,000.

Dr. Laws: Now this is what my mind has gravitated to and you will excuse me for blurting it right out. Prof. Sanborn is of the opinion that the barn can be built inside of ten thousand dollars, or in other words that twelve thousand dollars will build them both. But of course this is only his opinion, he does not know that they can be built for this amount. My judgment is to commit this part of the work to the executive committee, Messrs. Potts, Smith and Sanborn, with all the papers we have here and all the estimates, and leave it for them to look into and adjust, and perhaps they will call the Board together again, or if they see their way through, they can attend to it themselves. My judgment is to make them an executive committee with power in this matter.

Now I will bring up one additional point: We have six thousand dollars of the State; it is understood by these gentlemen who are farmers, that those improvements in regard to the dairy and farm as there planned come so near the intentions that all parties here have that it is thought that it is desirable to realize the plans as near as practicable.

We all know six thousand dollars will not do it, but we think ten thousand dollars will do it. The Board has six thousand dollars at its command; now how are we going the bridge over the difficulty? How supply the deficiency? There are several ways that might be indicated.

Mr. Coleman: Where did you get six thousand dollars?

Prof. Sanborn: Six thousand dollars was appropriated for the barn.

Mr. Coleman: The session acts of the State says that the appropriation for cattle, sheep and barn, and for apparatus for experimental work is $8,000. If you will look at the original bill you will find it this way.

Prof. Sanborn: I absolutely know it was only $5,000 and the $8,000 is a mistake.

Dr. Laws: I have the bill here but it leaves out this matter altogether.

(Here the Secretary will explain that neither Dr. Laws nor the Secretary had seen the original bill after the amendment and only saw the amounts on the amendment. The same was true of the other members save Messrs. Coleman and Doud.)

Hereupon ensued a discussion as to whether the bill appropriated $5,000 or $8,000 for the cattle, sheep and barn. Different bills were read, enrolled bill, amended bill, original bill. etc., and the conclusion was reached that the amendment substituted the words in the sixth line instead of the fourth line of the original bill, thus making the appropriation $8,000, or $14,000, or at least something more than was supposed. If the $8,000 was appropriated the question arose, could it be spent for any of these specific purposes, as the law clearly set aside so much to be invested in each separate article. The question remained undecided and the Board proceeded to business.

Mr. Doud: The bids that have been handed in have been extortions, there is no question of that. I move that a committee of three be appointed to act with the Dean and see how cheap we can build the barn ourselves.

Mr. Fulbright: We were called here to either accept or reject these bids, and if the present construction of the law is right we have fourteen or eighteen thousand dollars, enough to build the houses; and if the construction of the law is not right we have not enough to build the houses. I think if the six thousand dollars is the limit and we have no more; or if we have got fourteen or sixteen thousand dollars, and I understand that Mr. Coleman's construction is correct, it is all

the same thing, we are here to accept or reject the bids that have been opened.

Mr. Coleman: I think it is evident that the law has gone out to the people and they have based their bids on it. For what was the use of them putting in bids for fourteen and sixteen thousand dollars if they thought we had not near that much money to spend.

Dr. Laws: Why, every one of them knew it; the legislature passed the bill with their eyes open.

Mr. Leonard: I make a motion that the bids on the barn and house be rejected.

Chair: You have heard the motion as put by Mr. Doud, are you ready for the question?

Prof. Sanborn: What are we going to do after that?

Mr. Coleman: I think the only thing we can do is to reject all these bids and leave the matter open to the committee. We will have to advertise again and get other bids.

Mr. Leonard: Suppose we get other sealed bids and do not make a selection, then what will we do?

Mr. Coleman: We can specify the amount in the advertisement. All of these bids are wrong. These men have evidently made them on the supposition that the amount was fourteen thousand dollars. There is only one way to get at this matter, either to except one of these bids or advertise again.

After a long discussion a vote was taken with the following result: Seven votes cast, all in favor of the motion.

Upon rejecting the bid on the house, a long general discussion was renewed, of which the following is a brief part.

Mr. Coleman: I have been reading this law over and over, and I am convinced that the six thousand dollars is all we have. I have the law here and if you will look at the amendment you will find it is amended just this way. This is all we can spend for the barn.

Mr. Doud: We can spend that eight thousand for apparatus.

Dr. Laws: The Board will have to have another meeting. The whole idea of rushing this matter through is impossible.

Mr. Leonard: I understand Prof. Sanborn to say that the improvements can be made for two thousand dollars.

Mr. Laws: That is his opinion, but he does not know.

Mr. Coleman: I believe it is the power of the board to delegate the power to the Dean to have the house and barn built.

Mr. Doud: The law says this: "The Dean of the Agricultural College shall expend the appropriation in the following manner: The Dean shall advertise for bids for all the items enumerated in at least

two daily and four agricultural papers in the State of Missouri; and all bids shall be sealed and addressed to the Dean of the Agricultural College at Columbia, Boone county, Mo., and upon receipt of the same the Dean shall notify the President of the State Board of Agriculture and he shall immediately call a meeting of the State Board of Agriculture, for the purpose of opening all bids; and each item shall be considered separately, and each shall be subject to acceptance or rejection: Provided, none of the bids shall be accepted unless a majority of the board vote for it."

Mr. Leonard: Suppose the secretary advertises again, and then suppose we get the bids and come here and cannot accept any of them we will have to keep on coming and we will bankrupt the Board and spend all the money coming here to Columbia. I believe it is the power of the Board to go along with discretion and do the best they can.

Mr. Coleman: It is my idea that the will have to advertise again, as we have rejected all the bids. But there is no use in advertising now until we know whether the appropriation is six or fourteen thousand dollars. The bids should be made accordingly. I am at a loss to know how much money we have, I know it was the understanding of the parties here that it was six thousand dollars, and I think it was the intention of the legislature. But I am at a loss to know just what is the correct construction.

Prof. Sanborn: There are many of these mistakes made. We have no right to say what was the idea of the legislature in passing this bill appropriating this money.

Mr. Doud: But it is not in our power to use it for the purpose we want. It is for "farms" and not "barns," and I do not believe in evading the law. I am in favor of going in and asking the Legislature to transfer the $8,000, and the quickest way to do this is to have the whole thing advertised.

Mr. Leonard: I move that a committee be appointed to take this law to the Governor and have a consultation with him about what it means.

After some interruption Mr. Leonard continued: Put the question. What is the use of having an executive committee if it is not going to do anything?

Chair: The motion is that authority for completing the arrangement for the building of this college barn and for the improvements contemplated in the bill be delegated to the executive committee of the Board. And that they shall call the Board together to approve of whatever arrangements the executive committee have completed. The

Board shall have the power to accept or reject, but the whole arrangements are left with the committee.

Mr. Doud: The law does not permit anything of this kind, and I will not vote for it.

Mr. Leonard: I am inclined to listen to Mr. Coleman on matters of this kind. What do you say, Mr. Coleman?

Mr. Coleman: The only way I acted on things like these was through sealed bids, and we have rejected all the sealed bids.

Mr. Fulbright: I will ask Mr. Leonard to make a motion to appoint a committee consisting of the President, Mr. Smith, Mr. Leonard and the Dean as the executive committee. We need the committee, and after we have it, they will take everything into consideration and see what is the best way, and if they think it necessary to make sealed bids again, they will do so, but we will leave the work for them to do.

Mr. Coleman: I suggest this point of law: we have come here as Board to act upon the sealed bids. I believe that if any plan is adopted by which the contractors come here and erect these buildings, and this Board should meet without advertising and act under this law, that an injunction would stand if served against this Board. One man can come, and knowing what the other bids are, can say, "I can do this work for $500 less."

Mr. Sanborn: We propose to advertise again.

Mr. Coleman: The only question is about how much money we have.

Mr. Doud: Is the executive committee any better able to know what these bids are than the Board is?

Mr. Fulbright: The entire Board can not stay here for several days and investigate the matter and the executive committee can. It is after all subject to the approval of the Board, and we cannot stay here nor go and consult with the Attorney-General.

Mr. Leonard: We can leave the matter with the Dean.

Chair: If I understand the object of the gentleman who wants this committee, it seems that he does not want to call this Board together unnecessarily.

Mr. Coleman: I think the bids were made on the supposition that there was $14,000. I am willing to let the committee go ahead and build the house; I see no trouble on the point. I am willing to vote for the resolution.

Prof. Sanborn: It will cost two hundred dollars every time we meet, and the Board has but little money to spend this way.

After a long discussion a vote was taken resulting in seven votes for and one vote against the resolution.

Prof. Sanborn: I would call your attention to the fact that the Secretary has put in a bid for three or four items; for student labor, $1,000; experiment work, $2,000; sheep, $500; hogs, $250, and cattle $3,500.

Dr. Laws: It seems to me this is analagous to the case of Dr. Paquin, and I think it could be carried in the same way. As to student labor, that is an exceptional case; I think the Dean can go forward and utilize that labor with the presumption that the Board will sanction what he does.

Prof. Sanborn: Reading the section relating to this item, I only want the power to expend the money for the purchase of the animals.

Dr. Laws: Could you not purchase the animals conditionally? The word "bid" there used as "offer."

Prof. Sanborn: I bid as Sanborn; not as dean.

Mr. Doud: Mr. President, I think the bid on the cattle is the easiest bid we have, and I will state just how it can be done. The dean in advertising for sealed bids can prepare specifications for that item. He can say, "I want so many Galloways, and names the kind, age and number wanted." He can do the same way with the Herefords, Angus and other varieties wanted. Now Mr. A wants to make a bid on such and such an animal. He stipulates the kind of animal, and offers his bid, and the Dean sends for this Board to receive or reject the bids, and we know how to act on them. And there will be no implication on the Dean offering a bid simply to comply with the law. This bid does not say whether there is one or one hundred animals to be bought. The motion is to settle the bid.

Mr. Leonard: I make a motion that the first bid be received—the one on student labor.

Carried unanimously.

The next vote taken was on experimental work, with seven votes for and one vote against the motion.

Mr. Doud: I will explain my vote. I think items of this kind should stipulate in what direction the money should go. That is why I voted no.

Prof. Sanborn: I will explain it.

Mr. Doud: The board will have to meet again, and you can explain it then.

The next vote taken was for the purchase of hogs. To accept Prof. Sanborn's bid of $250.

Mr. Coleman: I move we accept it.

The roll was called, resulting in a unanimous vote for the motion.

The next motion was to accept Prof. Sanborn's bid of $500 for sheep.

The vote stood seven for and one against; the motion was, therefore, lost.

The next motion was on Prof. Sanborn's bid of $3,500 for cattle.

Mr. Coleman: I know nothing about cattle, and am prepared to favor what those who do, think best.

Mr. Fulbright: I think we ought to get perfect animals to show the boys. Everything used for the purpose of instruction ought to be the best of its kind.

Dr. Laws: It is utterly impossible to get cattle in any other way.

Mr. Doud: I would like to explain; there is nothing to show how many animals he wants.

Prof. Sanborn: That cannot be shown when you have to spend different amounts for each animal. Some will cost mor · and some less.

Mr. Smith: I am a stock dealer and buy a good deal of cattle and this is the only way to get those cattle. One man can buy them better than all of us together can.

Mr. Coleman: I think Mr. Doud's plan is just as impracticable as it possibly can be. Suppose you advertise for 16 Galloways.

Mr. Doud: The Government in offering bids reserves the right to take more or less; the board can do the same.

Dr. Laws: Let us have the vote; there is no use having all this talk, it don't amount to anything.

Mr. Leonard: I look at it that there is no other way to do it.

Mr. Doud: The point is right here; Prof. Taft said he needed a part of that money and it is not right to not give him anything.

Dr. Laws: Prof. Taft is associated with Prof. Sanborn, and do you suppose Prof. Sanborn would take away from his colleague a part of the funds?

Mr. Doud: We can dispose of this matter and then if any body wants to change it he can vote for a reconsideration.

Dr. Laws: You are the only man that can vote for a reconsideration.

Chair: The secretary will call the roll of the vote on the cattle: Chairman, aye; Dr. Laws. aye; Mr. Coleman, aye; Mr. Leonard, aye; Mr. Fulbright, aye; Mr. Doud, no; Mr. Smith, aye; Prof. Sanborn, aye.

Motion lost, seven ayes and one no.

Mr. Doud: Mr. President, I move to reconsider the vote by which Prof. Sanborn's bid for experimental work was lost.

Dr. Laws: I second the motion.

The roll was called for another vote on the bid for experimental work, which resulted in the unanimous vote being cast in favor of the motion.

The bids for the sheep and cattle are lost; and also those for the barn and house.

Prof. Sanborn: I want these sheep now to put in the pasture to eat down the bushes.

Chair: If I understand it, Mr. Doud, you changed your votes on the sheep and cattle.

Mr. Doud: I am in favor of the sheep, but I have not changed my vote on the cattle. I will now move to reconsider my vote by which the bid on sheep was lost.

The motion was seconded and the roll was called.

Chair, aye; Dr. Laws, aye; Mr. Coleman, aye; Mr. Leonard, aye; Mr. Fulbright, aye; Mr. Doud, aye; Mr. Smith, aye; Prof. Sanborn, aye. Motion carried.

Mr. Doud: How long before we are going the meet and see about the barn?

Prof. Sanborn: As soon as possible.

The motion for adjournment was voted on and carried.

[Extract of report of Miss Laura Matthews, stenographer for the occasion.]

J. W. SANBORN, Secretary.

PROCEEDINGS OF THE STATE BOARD OF AGRICULTURE.

AGRICULTURAL COLLEGE ROOMS,
COLUMBIA, MO., May 31, 1887.

The State Board of Agriculture met in the Agricultural College rooms at 10 A. M., May 31, 1887, in pursuance with a call of the president, Mr. Potts, for the purpose of opening bids and letting contracts on items specified in Senate bill No. 95, that remained unlet from the meeting of April 29, 1887.

House called to order by President Potts.

Roll call showed the following members present:

Dr. S. S. Laws,

Hon. N. J. Colman,

J. A. Potts, President,

F. W. Smith, Esq.,

B. O. Cowan, Esq.,

M. F. Doud, Esq.,

J. W. Sanborn, Secretary,

Prof. J. W. Sanborn read a communication from Prof. S. M. Tracy tendering his resignation as treasurer of the State Board of Agriculture, the resignation to take effect immediately on notice of the election and qualification of his successor, or directions as to the disposition of the funds yet in his charge.

Chair: What is your wish; shall we accept the resignation?

On motion of Gov. Colman and seconded by Mr. Cowan, the resignation was accepted.

Mr. John S. Clarkson was nominated for treasurer by Prof. Sanborn, and seconded by Dr. Laws.

Ballots was prepared and the vote taken, which resulted in five votes being cast for Mr. John S. Clarkson and two votes for Mr. F.W. Smith.

Mr. Clarkson was declared elected.

Moved by Prof. Sanborn that a committee be appointed to settle with the treasurer. Carried.

The Chair appointed Messrs. Cowan and Smith to constitute the committee.

Moved by Gov. Colman that a committee be appointed to notify Mr. Clarkson of his election at once, that he be requested to have a bond ready as soon as possible, and that he aid in the settlement.

Prof. Sanborn: I ask, in regard to the $8,000 in dispute, that the Board go over the farm and see how badly the money is needed and if after that the Board sees fit to draft resolution, setting forth its great need it will aid the executive committee in its efforts to secure the same.

Dr. Laws: After some deliberation, I have concluded that it is the treasurer's business to look after the money belonging to, or coming to the Board, and where there's a difference of opinion he should investigate it. He here explained the situation for the benefit of those present who were absent at the former meeting. If Auditor Walker should hesitate to pay over this amount, continued Dr. Laws, the treasurer would represent this Board by calling a writ of mandamus, which would give the court an opportunity to decide the case. All this could be done without ill feeling and the harmony now existing need not be destroyed. I deem it our duty to go for the whole amount.

Gov. Colman: If we can get it legally, I say get it.

Dr. Laws: Is this not legal?

Gov. Colman: It seems so, surely.

Mr. Cowan: I would like to ask what time and place will be most convenient to settle with the Treasurer.

Chair: Exchange National Bank at 2 P. M., to-day.

On motion, the meeting adjourned to meet at 7 P. M.

EVENING SESSION.

Board met according to adjournment.

President Potts in the chair.

The roll was called and showed the following present:

Dr. S. S. Laws.

J. A. Potts, President.

Abiel Leonard, Vice President.

Hon. N. J. Colman.

Mr. B. O. Cowan.

Mr. J. H. Fulbright.

Mr. F. W. Smith.

Mr. M. F. Doud.

J. W. Sanborn, Secretary.

Dr. Laws: I move that we go into executive session, which was seconded.

After a bitter opposition by Mr. F. Doud, a vote was taken in the usual way, and the chair declared the motion carried.

Mr. Doud: I call for the ayes and noes.

The roll was called with the following result:

Dr. Laws, aye.

Prof. Sanborn, aye.

Gov. Colman, aye.

Mr. Cowan, did not vote.

Chair, did not vote.

Mr. Doud, no.

Mr. Leonard, aye.

Mr. Fulbright, aye.

Mr. Smith, did not vote.

Result: Five ayes, and one no. The motion was carried.

Mr. Doud: I wish the Secretary to enter my protest against this secret session, and make note of the fact that M. F. Doud shall be bound to keep nothing secret that transpires in this meeting.

Mr. Leonard: I desire to say that I will not bind myself to keep any secret, but my reasons for voting "aye" were to avoid a controversy similar to the one we were drawn into after the last meeting, which has injured us seriously. Besides, I believe we can transact the business for which we met to a better advantage and quicker in executive session. These are my reasons for voting aye. I am not sorry I voted that way, and am prepared to vote aye again if the question is put to the meeting.

Mr. Fulbright: I move that we proceed to open the bids. Carried.

The bids were read and are to be found on file in the office of the Secretary.

Gov. Colman: I move that the bid of Messrs. Stewart, Duncan and Miller on the barn be accepted.

Seconded, and carried unanimously.

Gov. Colman: I move that Mr. Sexton's bid for building an addition to the Farm House be accepted.

Seconded, and carried with a unanimous vote.

Gov. Colman: I move that Turner McBain be given the contract to buy or furnish cattle for the State Farm.

Carried by a unanimous vote.

Prof. Sanborn: I move that Mr. McBain be also awarded the contract to buy carts, tools and horses.

Carried unanimously.

Dr. Laws: I make a motion that Mr. F. W. Smith's proposition and bid for the expenditure of the $8,000.00 according to the terms of the law be accepted, provided the money be received by the Treasurer of the Board.

Carried without opposition.

Moved and carried unanimously, that Mr. Clarkson's bond be accepted and placed on file.

Moved by Gov. Colman, that the matter of bonds with contractors be referred to the executive committee of the Board for acceptance.

Voted unanimously.

Suggested by the Chair, and moved that Mr. Smith be added to the executive committee.

Carried unanimously.

Mr. Leonard: I move that Miss Laura Matthews' bill for stenographic work be paid. Carried.

A report of the committee appointed to settle with the Treasurer was called for, and the following report submitted in response:

"To the State Board of Agriculture:"

"MR. PRESIDENT: Your committee appointed to audit the account of the Treasurer, Prof. S. M. Tracy, beg leave to report that they have examined the accounts made since the last settlement, covering a period from Nov. 4, 1886, to May 31, 1887, and find the vouchers for all expenditures properly signed, excepting two—Nos. 1 and 2, aggregating $57.50—which were signed by only one member of the executive committee, and we find the footings all correct."

"We find the following sums due the Board from the Treasurer, namely: From the regular appropriation of the General Assembly, $2,268.67, and from the special appropriation, $22,884. 3. The balance sheet presented your committee by the Treasurer, Prof. S. M. Tracy, is herewith appended."

"B. O. COWAN,
"F. W. SMITH,
"Committee."

Moved by Col. Colman, that the report of the auditing committee be accepted.

Carried by a unanimous vote.

Moved by Dr. Laws, that the receipt of the money shown by the above report to be now in the hands of S. M. Tracy, by Mr. Jno. S. Clarkson as Treasurer of this Board operate as a complete discharge of Prof. S. M. Tracy as Treasurer of said Board. Carried.

Moved and carried, that the Board adjourn until 9 A. M., to-morrow.

MORNING SESSION.

MEETING 9 A. M., Wednesday, June 1, 1887.

Meeting called to order by President Potts.

The minutes of yesterday's meeting were called for, and a controversy followed, but ordered that they be not read.

Moved by Mr. Sanborn, that the bids of Stewart, Duncan and Miller be reconsidered, as they were vague, and the firm would sign no contract when called upon. Carried.

Mr. Doud raised the point of order, that Mr. Sanborn should not read specifications. Not sustained.

Moved, that we enter into a contract with Stewart, Duncan and Miller.

[NOTE—Messrs. Duncan and Miller were in, and when requested to give bond, stated to the Board that they would not sign a contract upon the specifications, with the floor out, nor when called up would they define in writing what they would do.]

Moved, that this matter be laid over informally. Carried.

Moved and carried, that an invitation be extended to Sergeant Weber to present to the Board the subject of Weather Service.

Mr. Weber gave an interesting account of the service, and suggested that a combination of this service with the Board will cost but little and be of much value. He felt confident that the War Department will *frank* the circulars. Prof. Nipher has carried forward a State service at his own expense for a number of years.

Mr. Leonard: I desire to know what good we can get out of this service?

Mr. Weber: We can ascertain the local fluctation in temperature, etc., and its influence upon agriculture.

Moved that the Secretary be authorized to establish a State Weather service in conjunction with the Signal Service Department.

Mr. Fulbright: I am opposed to the motion.

Mr. Cowan amended the motion by limiting the cost to one hundred dollars for the first year.

Mr. Fulbright stated that he would vote for it under protest.

Carried as amended.

AFTERNOON SESSION.

Board met at 1:30 p. m., with President Potts in the chair.

The following members responded to roll call:

Dr. S. S. Laws.

J. A. Potts, President.

Abiel Leonard, Vice-President.

J. W. Sanborn, Secretary.

J. H. Fulbright, Esq.

J. R. Ripley, Esq.

B. O. Cowan, Esq.

F. W. Smith, Esq.

M. F. Doud, Esq.

Moved by Mr. Cowan that the Board go into executive session. Carried.

Moved that Mr. Sexton's bond be accepted. Carried.

Moved that we reconsider the vote by which the bid of Messrs. Stewart, Duncan and Miller on barn was accepted. Carried by unanimous vote.

Moved by Dr. Laws that we reject the bid of Messrs. Stewart, Duncan and Miller. Carried unanimously.

Moved by Mr. Leonard that Mr. Sexton's bid on the barn be accepted. Carried unanimously.

Moved by Mr. Rippey that the executive committee be instructed to sign a contract and accept a bond from Mr. Sexton.

The following resolution was introdued by Mr. Rippey and seconded:

Resolved, That Prof. Sanborn, Dr. Laws and Col. Smith be appointed a committee to prepare a careful and detailed statement of the action of Mr. Doud as a member of this Board; the amount of pay he has drawn in excess of the amount due him; his attempts to injure the in-

fluence of the Board by the continual misrepresentation; his occupation; his general character, and such other matters as disqualify him from being a member of the State Board of Agriculture, and present to His Excellency, John S. Marmaduke, for his consideration and action.

Moved and carried that the above resolution be amended by substituting the name of J. R. Rippey for that of Dr. Laws.

Resolution unanimously passed as amended.

Adjourned *sine die.*

J. W. SANBORN, Secretary.

MEETING OF THE EXECUTIVE COMMITTEE.

COLUMBIA, MO., August 18, 1887.

A meeting of the executive committee of the State Board of Agriculture was held at Columbia, Mo., August 18, 1887, with the following members present:

Mr. J. A. Potts, President.

Mr. Abiel Leonard, Vice-President.

Mr. F. W. Smith.

Prof. J. W. Sanborn, Secretary.

Moved that Mr. McBain's selection of one short-horn heifer from H. M. Vaile, of Independence, Mo., be purchased at $300. Carried.

Moved that Mr. McBain's selection of one short-horn heifer from M. W. Anderson, of Independence, Mo., be purchased at $250. Carried.

Moved by Prof. Sanborn that the Hereford heifer selected by Mr. McBain from Chas. Gudgell, of Independence, Mo., be purchased at $200. Carried.

Moved by Mr. Leonard that Mr. McBain be authorized to purchase three Hereford heifers from F. W. Smith, of Columbia, Mo., at $200 each. Carried unanimously.

Moved by Prof. Sanborn that the selection of two short-horn heifers from Chas. Leonard, of Bell Air, Mo., by Mr. McBain be accepted. Carried.

Moved and seconded that $1,997 of the amount appropriated by the last General Assembly for dairy, ice house and repairs be paid W. I. Sexton, the contractor.

Moved by Mr. Smith that John Christ be paid in full for material and work in constructing the veterinary laboratory and horticultural barn. Carried.

Moved and seconded that the Dean of the Agricultural College be authorized to put in floor and erect towers on the barn at a cost not to exceed $1,000; this amount to be borrowed from funds for tools until

the $8,000 be drawn, when the sum borrowed shall be returned. Carried.

Voted unanimously that Prof. Sanborn be instructed or allowed, if he thinks best, to buy Jersey cows in the East, either by correspondence or by personal investigation.

Moved and seconded that the three Jersey cows purchased of F. M. O'Fallon, of St. Louis, by Prof. Sanborn, be accepted. Carried.

Adjourned *sine die*.

J. W. SANBORN,
Secretary.

ANNUAL MEETING OF THE BOARD OF AGRICULTURE FOR 1887.

AGRICULTURAL COLLEGE BUILDING,
COLUMBIA, MO., November 8, 1887.

An adjourned session of the annual meeting of the State Board of Agriculture was held in the Agricultural College building at 7 P. M., November 8.

President J. A. Potts in the chair.

The following members responded to the roll call:

S. S. Laws, LL. D.,

J. A. Potts, President,

Abiel Leonard, Vice-President,

W. E. Coleman, Superintendent Public Schools,

B. O. Cowan, Esq.,

F. W. Smith, Esq.,

J. W. Sanborn, Secretary.

On motion of Mr. Leonard, the Secretary read a portion of the minutes of the last annual meeting and the proceedings of one of the special meetings held since the date of the last annual meeting.

Moved by Mr. Cowan, that the minutes of the last meeting be adopted. Carried.

Mr. Coleman asked for a report of the Agricultural Department of the University, its present condition, prospects and work it is doing.

Prof. Sanborn answered at some length giving data that showed the college to be improving, that its work was more appreciated and of more value than at any time in the past.

A general discussion of the work and purposes of the Board of Agriculture followed.

Dr. Laws explained that the industrial interests are under the observation of the Board, since the law creating the Board contemplates and provides for the meeting of the presidents of the Agricultural Societies with this Board at its annual meeting, and to consult and co-

operate. It seems to me that we are now neglecting this part of our duty and an amendment of our practice may be practicable.

Prof. Sanborn offered as an explanation of this seeming neglect of duty that it was also the duty of these societies to report to the Board, and they have entirely failed to do this. Hence we cannot keep track of them, as new secretaries are elected from year to year and they fail to report.

The Secretary, Prof. Sanborn, then called attention to the following propositions for their action:

I. Shall we offer premiums for best five acres of corn and for a power ditcher contest:

II. At the June meeting a committee was appointed to investigate and report to the Governor of Missouri the qualification, character and past action of M. F. Doud. The committee has lodged in the hands of the Governor papers conveying such information and he has been asked to remove Mr. Doud from the Board; shall we take further action?

III. After reviewing the present condition of the experiment proposed by the State Agricultural College of carrying forward a breed contest, the Secretary asked the Board, as they control the funds, to take some notice of it, etc., or action regarding it.

IV. I recommend the establishment of a weather service in connection with the Board. The Illinois Board of Agriculture issues weather bulletins with its crop report. The U. S. War Department allows the use of frank envelopes.

V. The Springfield Thresher Co., offers us a fine grist mill. We have an e gine, but at present there is no house or protection for it. It seems to me that it would be perfectly legitimate to use a portion of the money appropriated for tools for the purpose of protecting the machinery.

On motion of Dr. Laws, the executive committee was directed to pay the premiums offered for the best five acres of corn raised in 1887.

Moved by Mr. Coleman that the Secretary be instructed to write Mr. Bronaugh that in accordance with the provisions of the by-laws he is requested to resign. Carrried.

Moved by Mr. Cowan and seconded by Mr. Coleman, that the Secretary be instructed to inform Mr. Doud of the fact that information concerning his character and actions has been placed in the hands of the Governor and that the Governor has been requested to remove him from this Board. Carried by unanimous vote.

Moved by Mr. Leonard that Prof. Sanborn be allowed to use one

hundred dollars out of the $2,000 appropriated for tools for the construction of an engine house. Carried.

Moved by Mr. Cowan, that seven hundred dollars be set apart to defray the expense of holding Institute meetings during the winter. Carried.

Moved by Mr. Leonard that six hundred dollars be set apart for clerk hire. Carried.

Moved by Mr. Cowan that we proceed to the election of officers. Carried.

Moved by Mr. Coleman that all the present officers be re-elected. Carried.

Moved by Mr. Cowan that premiums on corn and tile draining be renewed for 1888. Carried.

Moved by Mr. Leonard that the Secretary be instructed to enter into correspondence with the U. S. War Department, relative to the establishment of a weather service. The cost of said service not to exceed one hundred dollars. Carried.

A communication from Gen. D. H. McIntyre concerning the legality of the Boards claim on the $8,000 appropriated by the last General Assembly was read.

Moved by Prof. Sanborn that the President and Treasurer be instructed to push the claim of the Board for the $8,000 and that they be authorized to commence mandamus proceedings against Auditor Walker to compel him to pay the same. The cost not to exceed one hundred and twenty-five dollars. Carried.

Adjourned to meet at 7:30 A M., November 9.

MORNING SESSION.

Met according to adjournment and meeting called to order by President Potts.

On motion of Mr. Cowan, Mr. Geo. H. Wallace, President of the Missouri Wool Growers Association was invited to address the Board on sheep husbandry,

Moved by Secretary Sanborn that a committee of two be appointed to settle with the Treasurer. Carried.

The Chair appoint Messrs. F. W. Smith and B. O. Cowan, to constitute the committee.

Moved by Mr. Leonard that we refuse to accept the barn in its present condition. Carried.

Moved by Mr. Cowan that the executive committee be asked to confer with Mr. Sexton, the contractor, and show wherein the barn is incomplete. Carried.

Moved by Dr. Laws that all other interests, including the house be committed to the Executive Committee. Carried.

Moved that this Board of Agriculture approve of the experiments with the breeds of cattle proposed by the Agricultural College and authorize the Dean of said college to use such part of the two thousand dollars devoted to experiment work as is needed to cary forward this experiment, and that we commend it to the favor of the Curators of the University of Missouri. Carried.

Mr. Wallace was called upon to address the meeting. He proceeded to set forth the value of the sheep interest of the State. He also called attention to the aid the Board of Agriculture could give to the industry by relieving a prejudice and partiality, by superintending the scouring of the wool of the annual shearings and recording the same in the reports of the Board.

Moved by Mr. Sanborn that the State Board of Agriculture take charge of the annual shearing of the Missouri Wool Grower's Association, if so desired by the Association, and that we publish the result. Carried.

Moved by Mr. Cowan that the expense be limited to the actual traveling expenses of one member. Carried.

The committee appointed to settle with the Treasurer made the following report:

"Your committee appointed to settle with the Treasurer of this Board, Mr. John S. Clarkson, beg leave to submit the following report: Amount received from S. M. Tracy, former Treasurer of the Board, $2,268.67; amount expended from this fund $1,303.66, leaving a balance due the Board of $894.26; amount received from special appropriation of the General Assembly, $22,884.53; amount expended from this fund, $13,861.64, leaving a balance of $9,022.89. We find warrants for all these expenditures properly signed, and find that account of Treasurer agrees with that of the Secretary."

F. W. SMITH,
B. O. COWAN,
Auditing Committee.

Adjourned *sine die*.

J. W. SANBORN, Secr tary.

PROCEEEDINGS OF THE STATE BOARD OF AGRICULTURE.

COLUMBIA, MO., Jan. 17-18, 1888.

At 7:30 o'clock, Tuesday evening, January 17, 1888, the Missouri State Board of Agriculture held a meeting in the Board room, in the Agricultural College building of the University, in pursuance of a call from the President, J. A. Potts.

President J. A. Potts called the house to order, and said:

GENTLEMEN: At the request of Governor Morehouse I have called this Board together for the purpose of adjusting a trouble that has arisen amongst us. This matter is to be deeply regretted, not only because two gentlemen of higher character and unquestioned honesty have cast reflections upon each other, but because their actions have invited public suspicion to the efficiency of the entire Board, which suspicion will tend to impair the usefulness of the institution we represent.

We owe it alike to ourselves and to the Agricultural College to take such action as will at once reconcile the trouble and bring its members into complete harmony. I feel sure that every gentleman will agree with me, that as public servants, our private grievances ought to be held in abeyance, as our paramount duty is to the institution we represent. Private wrongs should not interfere with public duty.

Trusting we may be wholly governed in our deliberations by motives inspired by that high sense of public duty as will fully satisfy the public and bring harmony among us, I await your pleasure, and will ask Governor Morehouse to further state the object of the meeting.

Governor Morehouse took the chair, and asked for the calling of the roll, which was done, and the following members responded: Governor A. P. Moorehouse, Dr. S. S. Laws, A. Leonard, J. H. Fulbright, F. W. Smith, M. F. Doud, J. W. Sanborn, M. W. B. Harman, W. E. Coleman, J. A. Potts, Judge J. W. Emerson.

Prof. Sanborn: I wish to state that I have received a telegram from Mr. Cowan, stating that he failed to make connections on a train, and will not be here until to-morrow morning on the train.

Governor Morehouse—Gentlemen: As this meeting of the Board of Agriculture was called at my request, perhaps it will be proper for me to state my reasons for calling the Board together. It had come to my ears from individuals, and I had seen in print in the papers throughout the State, that there was some trouble with the Board of Agriculture; and it was for the purpose of seeing if that trouble could not be fixed up in some manner—for the reason that the controversy has been doing a great deal of injury to this institution, whose interests we have in hand, and because I have always felt a great interest in the University, and particularly the agricultural part of it, having, as a member of the Legislature, on several occasions, voted for every bill introduced in the interest of that institution, that I called this meeting. I felt that something should be done. The members should harmonize, or else bad results would accrue. I trust that every member of the Board has come in the proper spirit, and that this matter can be adjusted amicably and satisfactorily, and that we may work harmoniously in the future. If, however, there is anything wrong done here, anything that is not for the benefit of the institution we represent, I want it to be laid bare before the people here, and before the whole State of Missouri.

I have no advice to give as to the method to pursue, for the reason that I do not myself know all the facts connected with the trouble. I only know that there is some trouble existing, and for the good name of the institution and the Board I want it settled amicably and to the satisfaction of all. What is the pleasure of the Board?

Dr. Laws: As preliminary to the regular business of the Board I wish to state that a committeee of the students is in the room, who have asked me to state their desire, but I will call upon Mr. Myer to state their purpose.

Mr. Myer was called upon, and stated that the students were assembled on the campus and requested the committee to ask the Board of Agriculture to adjourn to the chapel so that the students might have the pleasure of seeing the new Governor and hearing him speak to them.

Gov. Morehouse: I will say in regard to the subject that it is the duty of the Chair to observe the will of the body. I have no desire to go unless it is the desire of the Board. If it will take up much time, I will suggest that we have not much time to spare, but whatever is the will of the Board of course I will carry out.

Mr. Leonard: I move that we adjourn at the request of the students.

Mr. Harmon: I second the motion with the amendment, that it be for only half an hour or less time.

Judge Emerson: I move that we instruct the students that we will meet them to-morrow evening at eight o'clock.

Gov. Morehouse: I would suggest that it is almost impossible for me to stay here until to-morrow evening, unless it is actually necessary for the transaction of business. I want to leave on the morning train.

The question being put, it was voted to adjourn for thirty minutes.

On returning from the chapel, and in resumption of the work of the Board, Gov. Morehouse asked the pleasure of the Board.

Mr. Leonard: Mr. Chairman, I will make a motion that the Secretary of the State Board of Agriculture shall dismiss the mandamus proceedings compelling the State Auditor to issue a warrant in favor of the Board for $8,000.00.

Mr. Dond: I second the motion.

Gov. Morehouse: You have heard the motion of the gentleman from Saline, which has been seconded. Are there any remarks?

Prof. Sanborn: I would like to suggest that Mr. Cowan, who was here when the Board authorized the mandamus proceedings, and took an active part in the matter, is not here on account of missing a train; and I think it is due him that he have the opportunity to record his vote, especially as he has taken the pains to come here. Therefore, I suggest that we do not take the vote until in the morning after he comes.

Gov. Morehouse: The proper way to dispose of the matter is to make a motion to lay the matter over until in the morning.

Prof. Sanborn: I have no objection to the consideration of the subject, but I think it is due to Mr. Cowan, as he has once registered his vote on the subject, and as he is a prominent man from the northwestern part, and has an interest in the subject.

Gov. Morehouse: I would say that the Board can, if it is desireable, discuss the subject now, and move that the final vote be postponed to any future time, when all the members will have an oportunity to vote.

Prof. Sanborn: I will make a motion that the vote on this question be not taken previous to some hour after nine o'clock to-morrow morning.

Mr. Smith: I second the motion.

Mr. Leonard: I will say that I have no desire to have the vote cast during the absence of any member of the Board, and I will be only too glad to have Mr. Cowan cast his vote. I made that motion unthoughtedly, and will withdraw it.

Mr. Colman: I would like to ask what assurance we have that there will be a fuller meeting to-morrow than we have now. We do not know that all that are here will be here to-morrow. We have had due notice to come here to-night. The Governor says that he must go home to-morrow, and I have just been to Marshall to the bedside of a sick child, and I do not know that I can be here to-morrow. There are nine members here. Can not we all vote to-night and let Mr. Cowan register his vote when he comes?

Gov. Morehouse: The motion before the house is that no vote be taken in regard to the mandamus proceedings until some hour subsequent to nine o'clock to-morrow morning.

Prof. Sanborn: I beg to suggest that the hour designated is some time previous to the departure of the train in the morning, and none of the members can leave until the train does.

Gov. Morehouse: It has been moved and seconded, that a vote upon this proposition be not taken until some hour subsequent to nine o'clock to-morrow morning, those in favor of the motion say aye. Contrary, no. Carried.

Is it desirable to discuss the subject now?

Mr. Leonard: I do not care to discuss it, but would like to state why I made the motion I did. It was for the purpose that the greatest amount of good might accrue to the Board and to the institution. I have carefully posted myself in regard to this matter by writing to each member of the house committee having this matter in charge, and also to Mr. J. M. Proctor, Senator from Boone county, who advocated it in the Senate; and without a single exception, they say that the $8,000.00 item in Senate bill number 95, was not inserted intentionally. It was not the intention of the Legislature to appropriate that amount in connection with the other amounts appropriated for the Agricultural College here. These gentlemen also express themselves very forcible in regard to the action taken by the Board of Agriculture and say it is their opinion that, if we press this matter, the Agricultural College and the University will not get another appropriation from the Legislature again soon. These being my feelings and the feelings of others about this matter, it will give me the greatest pleasure in the world to have this bill dismissed. I want the Board to get it out of the way.

Gov. Morehouse: Mr. Potts, will you take the chair a few moments.

Mr. Potts in the chair, Gov. Morehouse said:

Mr. President and Gentlemen of the Board: This matter is one of vital importance to this Board, to the future success of the Agricultural Department of the State University, and to the great State of Missouri. As I said in the beginning, I hope that every member of the Board has come here for the purpose of putting anything wrong right; I hope we can talk the matter over as members of the Board, and come to a fair and honest conclusion—and when we have come to that conclusion, to act upon it.

The matter of $8,000.00 is but of little moment to the great State of Missouri; but the receiving of it by this Institution, if the people of this State, through their legislators, did not intend to give it to the Institution, might be of serious damage to it. I am a friend of this Institution, as I remarked before, and particularly to the Agricultural Department, and I want to do every thing in my power to further the interests of the Institution. As I said, I have always befriended it, and have, as a member of the legislature, always assisted the passage of any measure for the benefit of the Institution. But, in my opinion, the Legislature did not intend to give this Institution the $8,000.00. If they did not intend to give it, should we, as members of the Board having it under control, ask it or take it? Ought we to take it even if the cold facts or the law would give it? I will say that if the Supreme Court will pass upon this matter, you will get the $8,000.00, for the reason that t' ey do not go back of the acts of t e Legislature, except as they are presented to the State. An examination into the acts of the Legislature and the other facts would be made were the case taken to the circuit court, but it is not done in the Supreme Court. The Supreme Court takes the case as it stands and passes upon it.

If the Legislature did not intend to give this $8,000 we will be doing the institution an injustice and a positive harm to take it even if the law does give it to us. In order to lay this matter clearly before you, I have brought with me the original Senate bill, number 95, and the original amendment of the house (both in manuscript). There can be no doubt about their genuiness. With the permission of the chairman and gentlemen, I will read these bills, and it seems to me that we can come to a proper understanding so that we will not make a mistake and have it clear in our minds.

I would like to see the State University get the $8,000, yea, I would like to see it get $16,000 or $25,000, if so much could be properly spent;

but I am afraid if we take this $8,000, the people of the State of Missouri, after having investigated the matter, believing we have no right to it, would feel that we had defrauded it; and when the next Legislature meets we might go to it with all the eloquence and power and influence we could procure, and they would not give us a single solitary dollar.

Now, here is the original engrossed bill of the House, and here is the original manuscript. It is entitled "An act appropriating money to properly equip the State Agricultural College farm of the State of Missouri, by striking out all words and figures after the the word "for," in the sixth line of said section, and inserting the following words and figures: * * * * * * * * * *

Now, take the engrossed bill you will find that in the sixth line we read, "for cattle and sheep barn and proper apparatus for experimental work, $8,000." We also find that in the printed bill, which I have here also, that in the sixth line the word "for" occurs twice, and the $8,000 appears before the sixth line in the printed bill. The mistake has been made by the clerks in adding the words to be inserted to the printed bill instead of the engrossed bill. I can come to no other conclusion. It was so understood at the time that the $8,000 asked for by the Agricultural College was cut down to $6,000. I think this was a wrong decision, but it was the will of the people of the State of Missouri by their legislators. The question now is what should we do for the success of the institution. If we believe that the Legislature did did not intend to give us that $8,000, we can do without it. If we believe that it was a mistake, we can do without it. If a man in a business transaction should give you a five dollar gold piece instead of a five cents, what would you do? Would you give it back to him or would you keep it? If we believe that the people of the State of Missouri did not intend to give us that $8,000, we should say at once that we will not take it. Believing, as I do, that it was not the intention of the Legislature, but it is a mistake which makes it appear that we should have the $8,000, I shall certainly vote for the dismissal of the bill, and in my judgment, it will be for the good of the institution to have it dismissed. I believe the court would grant it. I have a letter from Gen. Smith, in which he says it will certainly be granted. There is no doubt in my mind but that we would get it if we would applied for it.

Mr. Coleman: I would like to say a word. Of course there have been a number of things passed through the papers, but laying all that aside, I want to state my views upon the subject. As I stated once before, when this matter came before the General Assembly, I was on

the floor, and the question was asked by a representative, "How much was the bill cut up?" and Mr. Salisbury said that it cut out every item of appropriation. If you will take this law and construe it, you will observe that it cuts out all the appropriation in the sixth line as in the Session Acts. I will say that the Legislature had nothing to do with this matter of the mistake; it was the clerks. This bill and others were hurried through in a few minutes, and you all know something of how easy it is for errors to creep in when a thing is done in such a hurry. The amendment was never printed in the House; it was printed just before it was carried back to the Senate, and Senator Proctor, the originator of the bill, accepted the cut and agreed that the best thing to do was to take the appropriation recommended by the Governor. If you will take the appropriation bill, leaving out the $8,000, and will lay it side by side along with Gov. Marmaduke's recommendation, you will find that every item occurs in both, and the same total is reached, $24,000.

I have letters in my pocket stating that it was the instruction of that committee on appropriations to require the clerks to cut out all appropriations and take what the Governor recommended. Now, in regard to the "for," there are two "fors" there. If you take the designated "for," in the engrossed bill, the $8,000 does not belong there. The question was much discussed in the Legislature—I heard the discussion—and when the men voted nobody held the document in his hand; the members voted on it without looking at it. Senator Proctor accepted the cut. Here it was also said that this appropriation was in accordance with the Governor's message I do not intend to vote for the using of a dollar of that money, when I know that the Legislature did not intend to give it to us. After we had gone and asked for $8,000, and that they had cut it down to $6,000 do you suppose they would just turn right around and make it $14,000 instead of $6,000. These are square facts in the case, and I can prove it. I say that the Legislature never intended to appropriate it. If you will find five men in the Legislature who voted for it, I will agree to never open my mouth again about it. Therefore I say, and say again, the reason I voted against the mandamus to compel the State Auditor to pay the money was, that it would damage the institution in the future. I want to state here that I never have stated that I wanted the Agricultural College farm removed from here. I never made any such assertion and never had any such desire. In the second place I have always been in favor of sustaining the institution, and I believe the best thing to do for its prosperity is to vote against the mandamus and accept the bill as amended.

I say again that if you take it to the Supreme Court it will be granted, for the Supreme Court looks only at the letter of the law and goes no further. But suppose the matter was brought before a circuit court, then you would never get a cent of the money. I do not know what the Supreme Court will do. It may give the money. I rather think it will—the Governor said he thought it would.

I am in favor of dismissing the mandamus. I am in favor of taking what the legislature gave us, and then go back in good faith and say to the next General Assembly "We have spent that and want more" and not to go there after having taken the $8,000 that was not intended to be given us. Those men who voted for the mandamus I have nothing to say against. They believed that the money honestly belonged to the Board, and I have never said anything against them. I will say again that I voted against the mandamus for the good of the farm. Whether you take the $8,000 or whether you do not, I will never vote for any of it; but just as sure as this Board votes for it we will never get another dollar from the legislature. Take the money that was given; act squarely and let the other rest, it will never create any discussion but will just lie there. I believe I was justified in voting against the mandamus. Suppose you get the $8,000 and no more.

Mr. Smith: Did not the Senate pass a bill appropriating $34,000 before it went to the House?

Mr. Coleman: Yes, sir.

Mr. Smith: The Senate passed it first for $34,000?

Mr. Coleman: Yes. Now these are the facts in the case. All I have to say in answer to Mr. Smith is that $34,000 was the amount I think they first made, but then they recommended to just cut out the whole thing and recommend what the Governor had recommended. He took the items in the same order including the hog barn, etc. And the bill was to be put together and enrolled. I have always voted against it and will still.

Prof. Sanborn: Did I understand you to say that the mistake was made by one of the clerks?

Mr. Coleman: I said the mistake was made between the time it left the house and before it got to the Governor. I suppose it was a mistake, but I do not know. I wrote some of the laws myself, my clerk was very busy, and the last morning of the session everything was in such a hurry, and all the bills had to be enrolled and read by the Governor. It is the easiest thing in the world to make mistakes under such circumstances. Yes, I think it was a clerical error.

Prof. Sanborn: I am very glad to have the gentleman make that statement, as it has been charged by some that there was fraud. I am

very glad to hear him say he thinks it was a mistake of a clerk.

At this point it was unanimously decided, on motion of Mr. Sanborn, to accept the report of the meeting as taken by the stenographer who had been employed to take down the proceedings of the meeting,

Mr. Doud: Mr. Chairman, for my own information, I understand. that Captain Kneisley, Representative from this county, was a member of the committee that considered this bill when it was before the house, and I move you that an invitation be extended to Captain Kneisley to explain the bill before him.

Gov. Morehouse: If there is no objection, Captain Kneisley will address the meeting.

Capt. Kneisley: Gentlemen, I would like to be interrogated. What do you wish me to state?

Gov. Morehouse: We want a statement as you understand it.

Capt. Kneisley: When the bill came before the committee and we were considering it we were importuned by Prof. Sanborn and Mr. Proctor, one day just as we were about to adjourn, to stay just a few minutes longer and hear their statement and pass upon the bill and approve or disapprove it. After Prof. Sanborn had made his statement the question was asked in the committee what disposition shall be made of the bill, and the committee being at leisure to discuss the measure it was brought up and then we went into executive session, and the same question was asked, what disposition shall we make of the bill? And Lincoln said we will give narry dam cent, and I said I would not advocate the bill for my seat in the house. If I had advocated the bill as manipulated by Sanborn I would have been passed out of the house. [The Secretary will state here that he has verbal, ocular and written evidence of Mr. Kneisley's hostility to the entire appropriation when he could do so beyond public view]. I said let us take what the Governor recommends and it was adopted. Babcock was instructed to take the bill and recommend what the Governor had recommended and it was reported and voted upon that way. Whether the insertion of the $8,000 was a clerical error or not I do not know, but there was something wrong somewhere—a "nigger in the wood pile" some place. I do not hesitate to say it. Prof. Sanborn knew we had cut out the $7,000 for cattle and sheep barn, notwithstanding he had said he could not do with a cent less than $24,750, but he became satisfied with the amount.

Prof. Sanborn: I would like to ask what he means by saying that the bill was mutilated by me?

Capt. Kneisley: It was made out in your own hand writing.

Prof. Sanborn: I deny the statement in toto.

Capt. Kneisley: The documents can be produced.

Prof. Sanborn: Produce them.

Judge Emerson: I rise to a point of order. It is that this discussion now arisen between the gentleman on the floor and Prof. Sanborn as to whether the estimates which finally entered into the bill were made by Prof. Sanborn or not, or by any body else, I think is entirely out of order.

Mr. Doud: I wish to say that this meeting, as I understand it, was called for the purpose of investigation, and if there is a possibility of wrong any where, I think it is entirely proper to bring it to light at this meeting. I think the gentleman is wrong as to his point of order.

Judge Emerson: You will notice, Mr. President, that the point of order is not in regard to the investigation of any thing pertinent to the subject. The point is that that discussion does not elucidate the matter at present. If the discussion of a purely personal matter will throw any light upon the question we are investigating—as to whether the appropriation was or was not made, I think it would be all right.

Gov. Morehouse: The question under discussion is the resolution offered by the gentleman from Saline, Mr. Leonard, that the mandamus compelling the State Auditor to pay the $8,000 to the Board of Agriculture, be dismissed; and the inquiry now being made is as to whether the $8,000 rightfully belongs in the bill, and in discussing that question that the greatest latitude may be permitted without violating the rules of decorum. The chair is of the opinion that the point of order is not well taken at this time; it has not reached that point yet. However, if it goes beyond that point, the chair will listen to the point of order.

Capt. Kneisley: This is the bill from which I suppose all these items were taken and from which Senate bill number 95 was made up. It was made up here, I suppose at least one month before the Legislature met, and was printed. I am reading from the biennial report of the Board of Curators of the University of Missouri:

"For cattle and sheep farm and apparatus for experimental work, $8,000; sheds and tool house, cow barn, dairy house, ice house, $2,000; two cottages for laborers, $1,200; for drainage and other improvements, $1,000; for 100 sheep, for experimental purposes, $1,000, swine, $500; pure bred cattle of various kinds, $7,000; horse and cow barn and towers, $2,000; horticultural grounds, $18,000; laboratory and museum, $1,000; experimental purposes two years, $2,000; student labor, $1,000; vaccine laboratory and apparatus, $5,000."

This is copied in the Senate bill, as I said, and amounts to $33,500.

Mr. Smith: Is that the bill that first passed the Senate?

Capt. Kneisley: Yes, sir.

Prof. Sanborn: I understand that he said that I mutilated that bill.

Mr. Doud: I wish to correct the impression that Prof. Sanborn has. The Representative said he manipulated the bill, and he understood it mutilated the bill.

Prof. Sanborn: If he means that I asked for the items, I agree.

Mr. Leonard: As we are here for the purpose of investigation, I would like for you (Mr. Kneisley) to explain to the Board, if you can, how this error might have occurred, or how this $8,000 crept into this bill. I have taken very strong grounds against the Board using this money, believing that we are not entitled to it, and it was appropriated through error of some kind. Now, if it is possible for you to explain how this mistake could have occurred, I think you would confer a favor upon this Board and upon the State of Missouri.

Capt. Kneisley: There are various ways by which a mistake of this kind might occur. It might have been through a clerk.

Mr. Leonard: The question was in reference to this particular bill.

Capt. Knesley: I can not explain in regard to this particular bill after it left the committee.

Mr. Leonard: It was just to get the matter clear that I asked the question.

Capt. Kneisley: I can draw inferences as to how it occurred.

Judge Emerson: I agree to some of Mr. Leonard's statements, and that is in regard to wishing the good of the Agricultural College. My idea is that, that which is best is what we should do. That which is honorable and right, and the best results will come of it.

I have not had the pleasure of meeting with the Board heretofore, so am in the dark about the discussion that has just taken place. I can very well see that at the time this matter was presented to the Board for action, they should act according to the appropriation act as it appeared in print, and that appropriated $33,000. I can very well imagine that in passing the resolution instituting the mandamus proceedings that the matter had not been discussed and investigated as it has since. None of them had the same information then, as now. Therefore, I can very well see at first sight, that almost any one, not knowing that any wrong was done might wish to investigate it at some tribunal possessing the proper machinery. Since then, however, probably a good deal of light has been thrown on it, whether it is a mistake or not, and a sentiment has been developed indicating that, contrary to the first impression, the appropriation was not actually intended, and so you naturally proceed with caution as to what would be the

right thing to do, and what would be the most expedient for the good of the Agricultural College Farm. I do not know the steps that have been taken, and do not know the action of the Board heretofore, and I would like to have Dr. Laws or Prof. Sanborn or some one, to explain it for the benefit of myself, and probably some other members not so well posted. I believe that everything has been done with a view to the best results to the Agricultural College and Farm.

Prof. Sanborn: As Mr. Emerson has called my name, and Dr. Laws now being busy, I will say, that I presume he wants a statement of the bare facts in the case. I am very familiar with this bill, as I have given it very careful consideration. When the bill first came up in the Board, my attention was called for the first time, to the $8,000 by a colleague in the Board, and I took it under consideration, and after giving it mature deliberation, I cast my vote for the mandamus. It was, and is my opinion, that the $8,000 belongs to the Board. When any new light is thrown upon the question, and I know I am wrong, I will, without reserve change my vote. So far, however, I have seen nothing to cause me to change my views, and unless cause occurs, I shall still continue to vote for the mandamus, even if my vote is lost. I have another word to say before casting my vote: The point has been raised that it is a mistake of the committee of the House. The committee of the House, as every one knows, is simply an advisory body, to which the bills of the House and Senate are referred. They simply take into consideration the bills, mature them and report their convictions to the House. The House does not always accept their convictions. Granting for a moment that the committee did make a mistake, yet we cannot overlook the fact that the bill reads "words for," somebody said "word," it is "words." There are no "fors" in in the fourth line, only one "for," but there are two "fors" in the sixth line of the printed bill. And even the plea that the clerk of the committee did make a mistake, cannot be satisfactorily explained, because it reads after the "words for" in the sixth line, and there is but one "for" in the fourth line.

Mr. Coleman: Do you say that it says after the "words for?"

Prof. Sanborn: Yes, sir.

Mr. Coleman: Well, then, how do you harmonize the words "for," in the sixth line, it cuts it out if you insert it in there?

Mr. Sanborn: You are in error there, as it cuts out all after both fors. I said granting for argument's sake that they intended to strike out the $8,000. What does that matter. It was simply their design. The

bill that passed the House of 140 members, contains the words, "after the words for, in the sixth line," and it had passed the House in that shape, and all had to pass upon it. Even granting that the House had made the mistake, it goes from there to the Senate, and the Senate voted it in good faith, and acted upon it in good faith, and passed it with the $8,000 still in it. Then granting that the Senate made a mistake, the same bill goes from the Senate to the Speaker of the House, then to the President of the Senate, and then to the Governor, and granting that they all make the same mistake, and still the Governor signed the bill with the $8,000 in it. I have this to say, we as a Board of Agriculture, stand intermediate between the State as a giver and the Agricultural College as a receiver. We are not the recipients. Some three or four hundred dollars of the Board's money has been expended in settling this question. We are the agents of the State to spend the money just as the State says. We are authorized to handle this money, and it is stated, as clearly as anything can be, that the $8,000 was there. The Attorney-General has rendered his official opinion that the money is given, and we now ask the courts to give the law in this case. And we can apply no moral principles, as the law simply directs us to expend it, and all we can do as sworn officers of the State is to spend the money for the college if the court so understands the law, and let the gentlemen who made the mistake answer to the State, and unless I get new light upon this subject, I stand upon this ground.

Mr. Doud: I would like to ask the gentleman if he believed at the time the bill was passed up to the meeting of the Board, that more than $24,750 had been appropriated?

Prof. Sanborn: I could only judge from the amendment I had seen, and it had only $24,750; I had never seen the original bill after the amendment.

Mr. Doud: I would like to ask the gentleman if he advertised for sealed bids with the understanding the $8,000 was appropriated?

Gov. Morehouse: That is not the question.

Mr. Doud: I wanted to bring out the entire business in perfect relief.

Prof. Sanborn: I will say that when I advertised for sealed bids for the work, I did it on the basis which I had at hand. I did not have the original bill, but had only the amendment.

Mr. Doud: What I wanted to say was this: The Secretary, in his advertisement for bids, omitted to mention any items mentioned in the $8,000 item, and he did not know that the $8,000 was there until Mr. Coleman called his attention to the fact while we were in session at the

Board meeting. He said he drew the bill, and had slept with it and knew it familiarly, and it was a mistake about our having the $8,000. When Mr. Coleman called his attention to it he had a certified copy of the Session Acts, and he said then it was a mistake and should not be there, that is why I asked the question.

Prof. Sanborn: I will say in regard to this matter, that while he has stated some things correctly, he has enlarged upon my statement. I admit I said I did not know the $8,000 item was there, and I did not know it was there. So I advertised upon the basis of the amendment, which was all the guide I had. But what has my opinion to do in this case? I simply had the amendment, and in looking the matter up I found the $8,000 in the original bill, then I acted upon the facts which seemed to me to be plain. I always want to act upon just convictions, and when new facts are presented, I accept them as facts when I have proof they are.

Gov. Moorehouse: I want to correct Prof. Sanborn in regard to the manner in which the bills pass the Legislature. If my theory holds, and the gentlemen who believe this is correct, no member of the House voted for the bill as published in the Session Acts. The bill went from the Senate to the House. There the amendment may be agreed to *viva voce* or by roll call. The amendment, if I am correct in my theory, was to strike out all words and figures after "for," in the sixth line. Then the bill came up in the House, as amended, and with the words stricken out, and the members voted on it as amended; the bill went back to the Senate so amended, and was agreed to in the Senate with the words stricken out after "for," in the sixth line. Consequently I say the rules governing legislative bodies, if we are correct, no member there voted on the bill with the $8,000 item inserted. My opinion is that when it went to the committee of enrollment, they had the enrolled and not the engrossed bill. That is the only way I can account for the $8,000 being in there. I read the bill over, every word of it, in the presence of senators, but you all know how bills are read under such circumstances. I read it quickly. Not one member in five, not one in twenty-five or fifty in the Senate ever hear a bill read through at length. It is only because it is required. I see gentlemen here that have been in the Senate and in the House and they will understand.

Prof. Sanborn: I hold in my hand the briefs of ex-Attorney-General McIntyre, and the opinion of Attorney-General Boone, and they have investigated the matter throughout, and they find the bill without a flaw in any stage. And the oposing counsel agreed that the points taken are true.

Mr. Coleman: These gentlemen never took into account the investigation we are making to-night. They just simply take the law as it is laid down in the acts. It is true that in their briefs they never bridged the question. It is a matter the Supreme Court would not listen to. We have admitted they would not. Therefore, when Mr. Sanborn brings this matter up, he is talking about something that does not come into this question. We have admitted that the Supreme Court would pass upon the letter of the law. But they never go back to inquire how the law was made. Therefore, what the gentleman says has no bearing on this question. The fact is, and we all recognize it, that these facts can not be brought out of the bill except through the circuit court. There and there only can it be tested. There is no use talking about the Supreme Court testing it. In regard to the moral question, I know that the bill never passed the Senate, and I know it never passed the House, and therefore I will vote against it here.

Mr. Leonard: Mr. Chairman, I wish to speak a word for Att'y-Gen. Boone. I have talked to a great many gentlemen in regard to this matter, and I have talked to Gen. Boone about it, and Gen. Boone thinks this matter all wrong. His opinion as Attorney-General is one thing and his opinion as a private citizen is another and a very different thing. This thing is all right before the law, but no one has expressed himself in stronger terms against it than has Gen. Boone. I am doing this thing for Gen. Boone, knowing that he would thank me and because I do not want to see him misrepresented.

Prof. Sanborn: I would like to enquire what the gentleman means by Gen. Boone being misrepresented.

Mr. Leonard: I mean the statement that Gen. Boone thinks this thing all right, and would leave the impression that Gen. Boone does not agree with the action of the house. As Attorney-General and as a lawyer he may think that the $8,000 was intended to be given, but I wish to say that as a private citizents he is not in favor of our pressing the claim and does not think that the legislature intended to give it.

Mr. Smith: I was appointed a committee of one to go to the trouble of going to Jefferson City to see about this matter. The treasurer told us to go to Attorney-General Boone with Mr. Walker's objection, and he said that Mr. Walker had no right to refuse to pay the money. He said it was not our place, nor Auditor Walker's to look after the mistakes of the house. He has given another opinion since then about the same thing, The Attorney-General may have changed his mind, but he has written a letter to the same effect,

Mr. Coleman: No man here doubts that Attorney General Boone made that decision.

Mr. Smith: I do not know what he says now but I know what he said then.

At this juncture the Secretary read the following letter from Attorney-General Boone bearing upon the subject:

ATTORNEY-GENERAL BOONE'S LETTER.

CITY OF JEFFERSON, Nov. 11, 1887.

HON. J. W. SANBORN, *Agricultural College, Columbia, Mo.:*

DEAR SIR: Hon. D. H. McIntyre called on me this morning and read your letter to him in reference to a mandamus proceeding against the State Auditor, compelling that officer to draw a warrant for certain appropriations made by the last General Assembly, approved March 31, 1887. Sometime ago I examined the acts at the request of Mr. Walker, State Auditor, and also Mr. Clarkson—and as I construe the law, your Board is entitled to draw the full amount specified in section I. of the Acts, and I so gave my opinion to Mr. Walker. I understand, however, that he declines to pay it. Of course I cannot act for your board in an action against the Auditor, and as I have already given an opinion adverse to the views of the Auditor, I cannot represent him in this matter.

So that if your Board desires to test the matter in the courts, you will have to employ special counsel for that purpose. Possibly I am wrong in my construction of the law, but I cannot give it any other construction—to my mind it is very plain—and leaves no room for doubt. Under the present circumstances it would not be proper for me to represent either side in the controversy. I write this letter at the suggestion and request of General McIntyre.

Very truly,

B. G. BOONE.

Mr. Leonard: That further light may be thrown on the subject, there is a statement here from Senator Proctor, of this district, who introduced the bill in the Senate. I talked to Mr. Proctor upon this subject and he is very earnest and strong in the opinion that we ought not to have this money. I wish he was here to explain the action of the Senate, but he could not stay to the meeting of the Board. I never saw the statement, but as he was in the Senate and took an active part in regard to this bill, I would like to have his statement read.

Mr. Turner McBaine said that he was in the office at the Powers House that afternoon and Mr. Proctor came in in a hurry to go to the depot and asked Mr. McBaine to write down a statement from his dic-

tation. The following is Mr. Proctor's statement as read by Mr. McBaine:

The Honorable State Board of Agriculture:

GENTLEMEN: I am exceedingly sorry that I could not be with you to day, as requested by many of the individual members of the Board, by reason of my business engagements. I write you this short note and hope you will receive it in the same kind spirit which prompts the author. Without presuming to advise or dictate in the least, I would respectfully suggest and state:

There is unquestionally an error in the bill appropriating money to the Agricultural College; as it was the intention of the amendment made by the House amendment to the Senate bill to cut out the $8,000 now in controversy. It was thoroughly discussed and so understood by myself and other friends at the time. I would, therefore, respectfully suggest and recommend to the Board of Agriculture that they do not demand or use the $8,000 in controversy, but refer it back to the next session of the legislature for more definite action.

I believe this would result in ultimate good to the institution.

J. M. PROCTOR.

Mr. Doud: Mr. Governor, this Board was called together to accept or reject the bids enumerated in the law, the 29th of last April. Before coming here I called upon Senator A. M. Allen from Jackson county, and got from him advanced sheets of the session acts. Senator Allen and myself went over that bill and we figured out $32,750. That was the first information I had received that it was that amount. When the bill was being considered by the House I was in Philadelphia; I was written to come home and lend all the help I could to that bill or it would be defeated. I came home at once. Stopping in Jefferson City, I talked to more than fifty members of the House concerning the bill, and they were all of the same opinion—the bill had been cut down to $24,750. Then when Senator Allen and myself went over the bill and found it $32,750 we were both surprised. When I came here to the Board meeting I found that it was a surprise awaiting every member of the Board, for they all thought that only $24,750 had been appropriated. When it was discovered by Mr. Coleman, I immediately took the floor and advocated that we draw the money but leave it lying in the treasurer until the next General Assembly, and then go frankly and ask that the money be transferred from this item to some other, for we had no use for the money for the farm. The secretary took the ground that we should have the money and the Board ought to spend

it as they pleased. I state this here so that the people here and in the State may know that I am not in sympathy with the mandamus and should have voted against it had I been present at the meeting. It has been flung at me since in Columbia that the scheme was in the fine Italian hand of Saline county for the purpose of removing the institution to Saline county. I want to say here that although the representative from Saline county did introduce the bill (an error, Secretary) in the last General Assembly and both of the members from Saline supported the bill. It was passed in the legislature, I believe, by a two-thirds vote.

Prof. Sanborn: Have not you said within a year "We will remove this college yet?"

Mr. Doud: I have not, unequivocally. I want to state that for the last five years I have advocated this institution, and on this platform I stand to-day and shall continue to stand until the plank breaks, for it is solid. I believe the Agricultural College is destined to be one of the greatest institutions in the great State of Missouri—and I do not say one word derogatory to the University either—the University has not a stauncher friend than myself. But I was born on a sand hill and raised on a farm.

Prof. Sanborn: Did not you say that you put it into the heads of the Saline county people to remove the Agricultural College from here?

Mr. Doud: I did not. Now, Mr. Governor, I do not wish to discuss the mandamus proceedings further; it is before the people of the State of Missouri. I stand here ready to vote to dismiss the proceedings. It is for this Board to say what they will do. I am not responsible for the actions of anybody but myself. Let each man go on record for himself.

Dr. Laws: I voted for this mandamus. I am not so sure but that I even moved it in the Board meeting when it was ordered. At that meeting there was present a quorum of seven, and five of the seven voted for the mandamus, and authorized the employment of a lawyer to prosecute it in view of the fact that the Attorney-General could not do so. When that mandamus was moved and voted by the Board we had the opinion of the Attorney-General that the Board was as much entitled to the $8,000 as to any other amount in the bill. We had also the professional opinion of Mr. McIntyre, who had formally served in the capacity of Attorney-General, and is now a lawyer of some eminence; and with the foundation of the opinions of these two gentlemen, the Board of Agriculture took the action to prosecute the mandamus proceedings. When the Board first met to carry into execution the law, this question was sprung upon it as a surprise, and when the Board

adjourned we were uncertain as to whether there might be some sort of a mistake. In the interval between the adjournment of that meeting and the subsequent meeting at which the mandamus proceeding was ordered, the professional and official information came to the Board and it acted upon the information then before it. I have felt that my action at that time, under the circumstances, was fully justified and unassailable; that the evidence then laid before us gave us no other alternative. I propose to act upon this occassion upon the information we have now before us. I am constrained to so accept this manuscript here as placed before us as the original bill as containing such information as we have never had before.

(The Doctor had been engaged in having the original bills copied on a reversible black board during the remarks of the previous speakers).

He continued: I have gone to the trouble of writing on the board here on one side the original manuscript bill, and on the other the original bill as printed. I think that a careful examination of them will help us to arrive at a conclusion. I confess I am surprised again. But I do not question that these are the original manuscript upon which the General Assembly passed in voting the appropriation to the Agricultural College and farm. Now, let me call your attention first of all to the printed matter as it here appears. It was the bill as printed, the Senate bill No. 95, and the House amendment, as printed, that we examined at our last meeting, and which we found to corresspond to the session acts as printed. Here (pointing to the board) are the lines of the printed bill numbered from one to six, and the amendment in the printed bill says that all the words and figures after the words "for,' in the sixth line are to be struck out. All the words and figures after the words "for," in the sixth line of said section in the printed bill—that is the sixth line of section one, and there are two fors in that line. Then all words and figures after both would be struck out. In the fourth line there we find the word "for," but this is not the sixth line. It seems to me that with the printed bill as before us, it is simply a matter of vision. Now, again referring to the manuscript bill we find that the expression "words for," in the printed bill, turns out to be "word for" in the manuscript. It is singular and not plural. Accepting this bill as a criterion, we are interested to know precisely what the amendment aimed to accomplish as the manuscript was before them. You will see that in the manuscript bill it reads, after striking out the word "for." Using the plural is a mistake of the printer. If you strike out all words and figures, after the word "for," in the sixth line in the manuscript bill, you will strike out all of the $8,000 item. We are all

here interested in knowing the facts in the situation. Again, I want to point out another variation in the printed bill from the manuscript; in the manuscript it says this money is appropriated for "cattle and sheep barns," and yet, when we turn over to the printed bill we find something that has puzzled all of us—we find the word "barns" is printed "farms," and "word" is printed "words," and the sixth line in the manuscript goes back to the fourth line in the printed bill as we have just seen. Now, I have done nothing in the world but simply put on the black board what our attention was called to. It seems to me that Gov. Morehouse has put light before this Board by bringing these bills here, that we could not have gotten from any other place. We all want to act on the facts as they exist. As the evidence lay before us when we met before there was no alternative left us but to vote for the mandamus; as the evidence is placed before us at the present time we feel constrained to say that there is an error some where, and we are bound to take account of it. If we could have found the printed bill to correspond to the manuscript bill, I could have seen no alternative but to pursue the mandamus and let the court decide upon it, whatever we might do with the money, did the court decide we were entitled to it.

Mr. Leonard: In regard to that word "farms," do you understand it to be a mistake?

Dr. Laws: I called the attention of the Board to the fact that in the manuscript bill it is "barns," a child four years old, I suppose, would be able to spell that word.

Mr. Doud: I would like to ask if he thinks the Legislature intended that we should build two barns, one for $8,000 and one for $5,000?

Dr. Laws: I do not feel inclined to answer any such inquiry.

Mr. Doud: If his theory is correct, they did intend for us to build two barns.

Dr. Laws: I do not feel called upon to canvass the question as to the intention of the Legislature in regard to that matter.

Prof. Sanborn: Was that original manuscript in the Senate?

Gov. Morehouse: No, sir; the original manuscript bill is here, however.

Mr. Sanborn: I would like to see the bill as drawn up by Senator Proctor.

Gov. Morehouse: It is here; that is the engrossed bill as it passed the Senate.

Mr. Coleman: Is that the bill as it went to the House?

Gov. Morehouse: Yes, sir.

Dr. Laws: The word "barns" is the same in both of them.

Prof. Sanborn: The bill was discussed at length. I was with the committee, and I noticed that the word was "farms" instead of "barn," and I told th · committee, but they seem to have let it remain.

Mr. Harmon: I would like to ask if it is not just as fair to presume that the printers have made the mistake as it is that any other party made it.

Gov. Morehouse: I will say, that whether the word is "farm" or "barn," is not the question; the question is whether the $8,000 was intended to be voted to the Agricultural College by the Legislature.

Dr. Laws: In calling attention to the singular and plural of these words I simply aimed to show that the printed and written bills did not agree. The same thing is true in regard to the words barn and farm. To say the very least about the printed bill, it was a bad piece of proof reading. We have the manuscript bill here, which shows that in the original bill the amendment struck out all the items of appropriation after a certain word; and the printed bill shows that when the words were stricken out, it left the $8,000 item. According to the printed bill, which was all the information we have been able to get heretofore, we seemed to have no alternative but to think that the $8,000 was intentional. According to the information we have before us now in the manscript bill, that first item in the Senate bill number 95, is stricken out beyond question, and does not come in at all. This item is stricken out, and the House bill takes the place of the Senate bill. My opinion was that the House amendment embraced the whole appropriation. I had no knowledge of this business, as it was run through the General Assembly, and got my information from the papers and the printed acts. When I went back and unearthed the printed slips and found the printed slips to be according to the session acts, and that both left in the line appropriating the $8,000, I saw no alternative for the Board, as servants of the State, but to use the money. I knew of no other way of getting at it, but by pressing the mandamus. We had consulted Attorney-General, Boone, and he informed us that that was the bill, and the counsel we employed was of the same opinion; but I find by referring to this manuscript that the printed bill does not correspond to it, and, accepting the manuscript as the original bill, I feel constrained to say, it will be very unwise in the Board to insist upon it—it will be the unwisest thing conceivable, in a word, for the Board of Agriculture to pursue this matter further. I am not influenced in this matter by these floating rumors and insinuations, I am influenced by these manuscripts, for when I see them I see that there

is a mistake somewhere. I do not want to know where it is. The fact that there is a mistake, is the thing. Feeling that there is some mistake which has crept into the matter, we should give the State the benefit of the doubt.

Prof. Sanborn: I would like to inquire if the mistake made by the committee is binding upon the House?

Dr. Laws: I have to say, that my opinion is, that we have here the manuscript which underlay the action of the General Assembly, and accepting that as given by the Governor, I say there is no alternative given but to acquiesce.

Gov. Morehouse: Mr. Sanborn will insist on saying the House passed this bill appropriating the $8,000. I want to impress the Board with the fact that if my theory is correct, the House nor the Senate, neither one voted for the $8,000 to be appropriated. They voted for the bill as it came from the committee with the $8,000 item struck out, and the committee on enrollment got it from the enrolled bill, and not from the engrossed bill. Perhaps, I am wrong myself, I do not mean to say that I know this is how it occurred. It was my duty, as presiding officer, to read them over, but I never interfered with the bills.

Prof. Sanborn: I am bound to say that the bill, on closer examination, looks differently. The committee was the responsible party, but I would stand by what the House did rather than by what the committee did.

Mr. Coleman: I wish to state right here, that the matter was fully discussed in the House, and all after the word "for" in the fourth line, for none of us had the manuscript bill, the chairman and all had the printed bill, and hence they said "for" in the fourth line. And the matter was discussed, and they cut out all after the word "for" in the fourth line, which is the same as the line of the manuscript bill.

Mr. Leonard: There has been a considerable said as to what should be considered evidence in this matter. In order to get at the sense of the Agricultural College bill I would like to make a resolution. We are here trying to solve the question before us and to get at the intention of the legislature. I will state the resolution; it is this:

Resolved, That the written word of the gentlemen composing the committee on appropriations, in the House, and that of Senator Proctor, should be of sufficient weight to make the Board of Agriculture hesitate in its use of this $8,000, at least long enough to consider whether it is right or wrong. If this testimony is sufficient I think we ought to respect it.

Gov. Morehouse: That is not a proper motion, for it would cut off all discussion of the subject, and that is what we came here for.

Mr. Coleman: I believe the motion was carried awhile ago that we should not vote on this question to-night but that it will be further discussed in the morning.

Gov. Morehouse: I do not know that it will be discussed in the morning, perhaps the vote will be taken without further argument.

Mr. Coleman: I would like to make a motion to take the vote now and let Mr. Cowan vote on it when he comes. We have got enough to do to-morrow.

Gov. Morehouse: The proper way to get it up now is to make a motion to reconsider it.

Mr. Doud: I move you, Mr. Governor, that we reconsider the former action and vote on the question now.

Prof. Sanborn: I hope the motion will not carry. I want to look into the matter further myself; and I want Mr. Cowan to have an opportunity of voting on it as well as the other members. There are other things we can consider to-night. I am not ready to vote on this question and I want Mr. Cowan to vote on it.

Mr. Leonard: I hope that motion will prevail. You have expressed yourself, Mr. President, as not being able to remain here longer than to-morrow evening, and there are other matters that will take up the time of the Board after this one is disposed of. If we want to discuss this matter we can do it fully to-night. I think the gentlemen here know how they are going to vote and I do not think the Board ought to stay here a day simply for the benefit of Mr. Cowan. And for fear that you will have to go away and that other matters will not come up, I am in favor of Mr. Cowan being allowed to vote on this matter after we have voted.

Dr. Laws: If I understand the situation, unless there are parties wishing to participate in the voting now, it is entirely proper to lay this subject aside and take up other business of the Board to-night.

Gov. Morehouse: Certainly that can be done. The question before the Board is, shall we reconsider the motion to not take the vote upon the dismissal of the mandamus until in the morning:

Dr. Laws: I shall vote against it for the reason that I think a measure of deliberation in this matter will be of benefit. I have no doubt but that the time between now and nine o'clock to-morrow morning would be of great advantage in forming our conclusions. Then there are other matters that can be considered to-night.

Judge Emerson: I am of the same way of thinking. I do not think any good comes of precipitating matters. We are here mainly

for the purpose of taking such action as will produce harmony and good feeling in the Board and in some way relieve the difficulty that has grown up out of this misunderstanding. As the resolution is passed with a view to allowing other members to arrive and vote, I hope the question of taking the vote at this time will not be pressed, but that we will vote upon it in the morning when the other member will be present. I do not think that any body's mind will change before the morning. My mind is clear as to what I shall do. I think it has been so clearly stated that the only question remaining is to determine what we shall do. I am very clear in my mind that we should decline to accept the $8,000 and I expect to vote that way. I have scribbled very imperfectly a resolution that I want to introduce. It It is intended to be the expression of the will of the board.

Gov. Morehouse: That is not in order now.

Judge Emerson: That was what I wanted to explain. We are here for the purpose of harmony, and whatever will bring that about will be the right thing. I think we should not stop on a bare resolution about the mandamus. I think it is right to pass the resolution dismissing the mandamus, but I think there is something to do now. It should come from this entire Board assembled here, or that portion of the Board that took this action. I think it very likely that nearly all of us would have voted for the action that they did, under the light that they had at that time. I do not feel like having a resolution passed indicating that we condemn the members who voted for it, that would not be in the right spirit. I think they acted for the best as far as they knew how. If we wait until in the morning to take this vote I will present in better form the suggestion I want to offer and will ask Mr. Leonard to withdraw his resolution.

Dr. Laws: Your suggestion, you say, will be simply a preamble.

Judge Emerson: Yes, sir; it will be in the form somewhat of a resolution, but I think the Board can accept it. It will not be quite so sharp as a bare resolution would be. For this reason I hope the motion will not prevail or that the gentlemen will withdraw it. We can take the matter up where we leave it off to-night.

Mr. Doud: I have no desire to railroad any measure through this Board and I have no object in view in wishing the vote to be taken to-night. I think the remarks of the gentlemen are very timely, and with the consent of my second I will withdraw my motion.

Mr. Leonard: I am willing.

Gov. Morehouse: The motion is withdrawn.

Prof. Sanborn: Before we make haste to withdraw the mandamus proceedings we need the advantage of very cool and clear heads. The

Board will be very precipitate to withdraw it until they have looked very closely into the whole thing. We have here the letters from the Attorney-General and Mr. McIntyre. They have examined the records and say that the amount belongs to us. I would not touch one dollar of it if I thought it was not rightfully ours. I want the matter looked into. I do not believe that there is a member on this Board of fourteen who would touch a dollar of it as a theft from the State of Missouri. Still I do not think we ought to hasten to withdraw the mandamus without further investigation.

Dr. Laws: I think it proper and believe the members will so recognize it that some one make the statement that I am about to make It is this: Prof. Sanborn was the most reluctant member to accept the idea that the $8,000 item was given to the Agricultural College; it was only after the printed bill came and every source of information we had seemed to make it a plain case that he accepted it as truth. I make the statement, in the full knowledge of the facts, that the Secretary did not lead off and grab at the appropriation. He only fell in line after the matter had presented itself to the Board, and when it was decided to institute the mandamus proceedings, I think his zeal in pursuing it was a virtue instead of a vice. And, without the information brought to us since the mandamus was instituted by the Governor, I would not have seen my way clear myself to have receded an inch in the case. But the case should be stated now according to the new light we have.

Mr. Leonard: In view of the fact that the resolution to vote on the subject to-night has been laid over until to-morrow morning, I will offer a resolution that the whole matter be laid over until Judge Emerson has prepared the resolution he referred to a while ago. I agree with Judge Emerson that we should try to get along as harmoniously as possible. Whatever action we think necessary in the matter, I think it would be well to defer the whole thing, and let the Judge bring in his preamble.

Gov. Morehouse: What is the further pleasure of the Board?

Mr. Doud: My information is, that one of the prime movers and founders of the Missouri Agricultural College, over which we are discussing to-night, was the Hon. James S. Rollins, now deceased. I therefore move you, Mr. Governor, that Mr. J. S. Clarkson be requested to prepare fitting resolutions to the memory of Major Rollins, and offer them to the Board to-morrow morning. Mr. Clarkson is one of the officers of the Board, and as an associate and intimate friend of Major Rollins for many years, is perhaps better qualified to draw up the resolutions of respect than any member of the Board.

Dr. Laws: I second the motion.

It was carried unanimously.

Gov. Morehouse: What is the further pleasure of the Board?

Mr. Leonard: If there is no further business before us to-night, I move that we adjourn until in the morning.

Mr. Doud: I would like to ask the Secretary if he has the minutes of the last annual meeting with him?

Prof. Sanborn: Yes, sir.

Mr. Doud: You will have them here in the morning, please, I want them read.

Judge Emerson. I want to get off on the morning train, if possible. If there is any other business of importance, I would like to have it brought up before the departure of the train.

Mr. Coleman: In regard to the discussion concerning the appropriation bill, I wish to say, that in the morning, if nobody else brings it up, I will, for I want to see if the law has been complied with. I have made some statements in the public press, to the effect that the money has not been expended according to law; and the Dean of the Agricultural College says I did not say it quite straight. I said that these matters were not let on sealed bids. If he has them, let him produce them. If he has the sealed bids, I will acknowledge before this Board, that I have made a misstatement. I am here to state all fair and square, and I would like to see the papers showing that the cattle, hogs and other things were bought according to sealed bids, and that the law was carried into effect.

Gov. Morehouse: The chair would suggest that the proper way to be, sometime during the meeting of the Board to introduce a resolution to the effect that the matter be inquired into.

Judge Fulbright: I do not understand that the gentleman will include these bids in the preamble he will introduce in the morning. I want to say, I know the spirit of the law has never been complied with. And I want to say further, I knew at the time that we were not complying with the spirit of the law. There is not a lawyer in the State of Missouri that could state what the Board ought to have done in regard to the bill and complied with the spirit of the law. If there is a lawyer in the State of Missouri, that can state it, he is wiser than anyone I have ever seen. We left it to the committee to do the best they could. I have no apology to offer. If the Secretary had had to have a sealed bid for each sheep and each hog and each cow, etc., and then called the entire Board together to open each bid, the entire $24,750 would have been expended to pay the board bills and expenses of

traveling to and from home, and we would have had no money to pay for the sheep and hogs and cows and cattle. (Laughter.)

Let us accept the crumb given us, for it was but a crumb. The farmers of this State pay almost the entire taxes of this great State of Missouri, and to think that the Legislature will give us just $24,750 as a representative of this great agricultural people. It is an insignificant little bit of a fixing anyhow. We ought to have had at least double that amount. But, as I said, let us expend what they have given us as honestly as we can. We cannot do it according to the law, but we wi l spend it honestly and squarely—that is we can spend it squarely and honestly in truth, but not in the spirit of the law on the sealed bids, but honestly and squarely as honest men. (Applause.)

The Board hereupon, adjourned until Wednesday morning at 8:30 o'clock.

MORNING SESSION.

At 9:20 o'clock, Wednesday morning, the chair called the house to order, and asked the pleasure of the Board.

Mr. Doud: Mr. Governor, I rise to a question of privilege. I call for the reading of the minutes of the last annual meeting of the Board.

Chair: Mr. Sanborn, have you the minutes of the last annual meeting with you?

Prof. Sanborn: Yes, sir; I did not observe the remark of the gentleman.

Mr. Sanborn read the minutes as requested; the point of interest to Mr. Doud being that a committee had been appointed at that meeting to investigate into his character, occupation, standing and qualifications as a member of the State Board of Agriculture.

Mr. Doud: Mr. Governor, in 1883, I was unfortunate, sir, enough to become involved with an individual in Kansas City, the result and outcome of which was fourteen law suits. Your experience as a lawyer, Mr. Governor, will make it possible for you to sympathize with the one under circumstances of this kind. Records on file in Kansas City will show that every one of those cases were decided in my favor. When that individual failed in the attempt to crush me there, knowing

that I was a member of this Board of Agriculture, he wrote letters to Mr. John Walker, State Auditor, at that time, and President of this Board, preferring charges against me, and impeaching the honesty and integrity of my character. I was notified of it, and at a subsequent meeting of the Board held at Higginsville, I notified the members of what was going on, and Professor Sanborn was the first one to get up and say if the court exonerates Mr. Doud, I see no reason why the Board should have anything to do with it.

I insist on pressing the matter that the investigation into the charges shall be made; and I assure the Board that if the charges are found to be true I shall immediately resign my position as a member of this Board. At a subsequent meeting of the Board, held at Mexico, I went to Mr. Walker and asked where the stage of the game was, and he said he had made the investigation and it was not worthy the attention of the Board, and he would not permit it to be put on record. This individual has since been indicted by the grand jury, a fact which Prof. Sanborn knew, because we talked the matter over in St. Louis. And because the State's witness could not be found the indictment was withdrawn. When I opposed Prof. Sanborn officially in this, for I never opposed him in any other way, we became involved in public controversy through the public press, and the first thing Mr. Sanborn did was to write a card to the St. Louis Republican, in which he could not find words strong enough to denounce me, but supplemented the card with a letter even more vindictive than the card dared to be.

Now, Mr. President, failing in this attempt to break down my character, he goes to Kansas City and goes to this individual that he knows to be without character, goes to that individual that he knew James Scammon got up in the United States Court and testified that the man's character was so bad that he would not believe him on oath, and he was asked these questions: "You have heard some very bad things said about this man?" Scammon: "I have." Question. "Have you heard some good things about him?" Answer: "No, sir."

There have been eight different responsible men in Kansas City to testify that they would not believe him on oath; he is known all over Kansas City as one of the greatest scoundrels that ever lived. And Prof. Sanborn went to him and got him to write a letter against the speaker before you, a member of the Board, and that letter is the outcome of the charges against me asking the Governor to remove me from this Board. Now, Mr. Governor, about two weeks after the annual meeting, I was unable to be here myself, I wrote to the Secretary

for a synopsis of the meeting, and through his clerk I got a reply giving a clipping from a Columbia paper, which was very brief, as to what was done at that meeting, and also that charges had been preferred against me asking, the Governor to remove me from the Board. This is the last I heard of it, for I took no action in the matter, knowing it to be so irregular, that I did not believe Governor Marmaduke would recognize it. Perhaps you know better than I what has become of it, but if there is a man in the State of Missouri that has more kind words spoken for him than Prof. Sanborn has from me I do not know that individual, if there is a man in the State of Missouri who, up until the time of the expenditure of the money appropriated by the Legislature, expressed greater friendship for the speaker than did Prof. Sanborn, I have failed to touch the flesh of his hand. I do not ask the Board to take my word; I have his written signature to substantiate every word. And yet that man could go and ask that individual that he knew was a black scoundrel, and him the successor of one of the best men on Missouri soil, and try to ruin the character of a man simply because he did not tody to him in those things he admitted last night were not right. Again, he has been writting letters, one of which I have in my possession, but forgot to bring with me, charging that his course was prompted because I myself asked him to do these things that were dishonest. He knows he never was asked to do a dishonest thing by me in his life; he knows that when we differed about things in the Board I told him so to his face. Every man that knows me knows that when I have anything to say against him I say it to his face. Now, later on, I shall ask to have this matter investigated once more, but not for myself, I stand on the merits of a man, and do not ask to have any resolutions passed exhonorating me unless I am made out as represented. I have a wife and baby in Kansas City entitled to protection, and I shall ask the Board to go there and investigate not only me but the gentleman that occupies one of the highest and most responsible positions in the State of Missouri. I hope when the motion is offered there will be no dissenting voice.

Prof. Sanborn: I do not propose to be engaged in a personal controversy in this matter. I beg, however, to assure the gentleman that he is in error when he says I am pursuing him in malice. It is not my desire or wish to persecute him. The facts in the case are well known to this Board, and he fully understands them however much he may desire to change the issue. I beg simply to state that at the meeting referred to, a motion was made by Mr. Rippey, a member of this Board, who is absent at this time, to the effect that Prof. Sanborn, Dr. Laws and Mr. Smith be appointed a committee to investigate the

standing and character of Mr. Doud. I had nothing to do with it except as a member of the committee. The motion was to appoint the committee to examine into the occupation, standing and general character, and such other matters as disqualified him for membership on this Board, and that the matter be presented to Governor Marmaduke for action. The vote was unanimously carried. Mr. Rippey was put on the committee instead of Dr. Laws, and I had nothing to do with it except as a member of the committee, whatever action was taken was taken by the committee. The committee reported adversely to Mr. Doud.

Gov. Morehouse: I will say that this is the first time I ever heard one sylable of this difficulty. I knew that Mr. Doud was a member of this Board, but I never knew anything about this matter, and it takes me completely by surprise. I never before heard it mentioned by an individual in this State.

Judge Emerson: If it is considered timely I would like to present the preamble I spoke of last night.

Gov. Morehouse: Yes, as we were on that last night it is proper that it should be brought up the first thing this morning.

Mr. Cowan: I was not present last night and would like to have the resolution read or at least stated.

Gov. Morehouse: The resolution was in substance that the Board order the mandamus proceedings in the Supreme Court dismissed.

Judge Emerson: Without prefacing the preamble I will read it as I have it:

"This Board expresses its opinion that the act of the Legislature, approved March 31, 1887, appropriating money for the Agricultural College and farm, as printed in the Session Acts, does, by its terms, appropriate the "eight thousand dollars," now the subject of the mandamus proceedings pending in the Supreme Court; and that the majority of the Board who authorized said mandamus proceedings had reasonable grounds for such action, based upon the information then possessed by them,—yet, nevertheless, on further information, since obtained, there appearing to be substantial doubt as to whether said "eight thousand dollars" item was intended to be appropriated by the Legislature, and as to whether said item was not in fact intended to be stricken out by the House amendment,—this Board, wishing to avoid the appearance of accepting or using any money not fairly and fully intended to be granted for the use of the said institution under the Board's control, hereby declines to further prosecute the mandamus proceedings, and directs their dismissal, and will await the further ac-

tion of the Legislature of the State, trusting that it will, in the future, renew said grant, with others sufficiently liberal to appropriately equip the State Agricultural College and farm."

The spirit of this resolution was expressed last night. The action taken by the Board heretofore, or a majority of the Board, was based of course upon such facts as were before them. The action, upon the whole, seemed to be reasonable and proper it seems to me, and they evidently acted in good faith, believing their duty, as trustees, made it necessary that some step should be taken to test the question as to whether the grant was made, or if it was a mistake or otherwise. But since then other facts have been developed, which make it doubtful and perhaps inexpedient for the future of the Agricultural College farm and the State. And the difficulty which might arise in the way of getting other and reasonable appropriations for the college and farm, make it very necessary that we be, if anything, over cautious in the matter, and not have the appearance of asking and accepting anything that was not given with good grace and in a kindly spirit. My impression is that the action of the Board, as expressed herein, will convince the people of the State of Missouri that the State Board of Agriculture is not accepting anything not intended to be given, and will accept in good faith what the Legislature gives, and whenever the Board of Agriculture is in doubt about an appropriation, it will solve the problem in favor of the Legislature, and refer the matter to them and ask them what their desire is. It seems to me that the expressions contained in this memorandum are only reasonable and just to the members of the Board who acted in this matter heretofore in all good faith according to the information they had.

Mr. Coleman: I would like to have the Judge read that resolution again.

The resolution was read again.

Gov. Morehouse: The question before the house is the adoption of this resolution as the other one was not written.

Mr. Cowan: I would like to ask Dr. Laws or Prof. Sanborn if it would not be well to modify that about the Agricultural College; I think it is said that this institution was under the control of the Board. The State Board of Agriculture has no connection with the college nor the farm except as this special appropriation was placed in our hands.

Dr. Laws: If Judge Emerson will simply put in the words "institution contemplated by this bill," that would remove all the difficulty.

Mr. Coleman: Cut the clause out; that will be the right way of adjusting it.

Judge Emerson: I will change it.

He read the clause after the insertion was made, and it was received.

The question on the resolution of Judge Emerson was put to the house, and carried unanimously.

Prof. Sanborn: I would like to have Mr. Potts read Mr. McIntyre's letter on the subject of the $8,000 item. It may throw some light upon the question. Mr. McIntyre had searched the records from beginning to end and gave that as his opinion.

Mr. Coleman: Will you allow a word? That just brings up the same question, and only consumes time without reaching any conclusion. That is a question of law, and is not the question we are talking about.

Gov. Morehouse: The gentlemen have a right to have the letter read; it is perfectly proper to have it read.

The following letter from Mr. McIntyre, and also a part of his brief, were read:

"JEFFERSON CITY, MO., Nov. 7, 1887.

Mr. Joseph A. Potts, President of the State Board of Agriculture:

SIR: In compliance with your request for my opinion touching the act of the General Assembly of this State, making appropriation of money for the equipment of the Agricultural College and farm, I desire to say, that I have examined said act, as well as all entries in the journals of the two houses of the General Assembly, relating to Senate bill No. 95, the act in question, from the introduction thereof to the signing of the same by the Governor. I have also examined such decisions of the Supreme Court of this State, and other authorities which I deemed pertinent to such questions as might be urged against the validity of this act, and especially as applied to the first item of appropriations in said act. In the first place I find no ambiguity or inconsistent provisions in any of the items of appropriation in said act. In other words, I find nothing upon the face of the act that militates against the regularity or validity of the act; nor do I find in the entries of the journals any indication whatever that any of the steps required to be taken by the constitution in the passage of bills has not been taken as prescribed in that instrument. Neither do I find any grounds of objection to the title of said bill or incongruity between the title and the contents of the body of the act.

My conclusion, therefore, is that said act is both regular and valid, and expresses the will of the Legislature and its intention according to the established rules for ascertaining the legislative intent. No legitimate inquiry can find any imperfection or defect in said first item, such

as would raise any question of doubt of its validity, and certainly no such doubt as would warrant any tribunal in deciding that the item referred to is without effect and inoperative.

In this short and very imperfect statement of my views, I have made no attempt to make any argument for these views, except by intimation, it would be entirely impracticable at this time.

My only attempt is to suggest the grounds of my examination, and to intimate the reasons upon which my views rest.

I believe that the Board is legally entitled to the benefit of the item first named in the act referred to, and that if the matter were properly presented to the Supreme Court, it would so hold. At the same time, I would not be understood as assuming to state that the court will hold as above indicated, but to express my belief and opinion predicated upon the examination made as aforesaid, and the consideration of questions involving the validity of this act, that such would be the holding of the court.

Respectfully,

D. H. McINTYRE.

Prof. Sanborn: He makes the assertion here that the bill is correct, and the claims of the brief in the case before the court by the attorneys on the other side of the question are agreed to, and it appears that the proceedings were according to the constitution and laws of the State as well as to the rules of the General Assembly. And no mistake was discovered in the bill from its inception, through its growth, and to the conclusion. Now, in view of these facts, and in view of the fact that Mr. McIntyre has been Attorney-General and is a lawyer of ability, and that care has been taken in every step to secure proper legislation, and in view of the fact that the attorney on the opposite side made no objections to the claim, I feel that there are just and sufficient reasons for letting the matter lie over for awhile. If it can be proved to my satisfaction that the mandamus is not for the best, or rather not just, I will be the first to vote that it be withdrawn. It seems to me that a good plan would be to appoint a committee, say, consisting of Mr. Potts, Mr. Smith and Mr. Coleman, the latter living in Jefferson City, to go to Jefferson City, and in connection with Gen. McIntyre, look the matter over carefully again, and if they agree in thinking that the mandamus should be dropped, we will abide by their decision. There is so much involved that I feel it is due us and the public that a little deliberateness be had in the matter. If it turns out as it appears on the black board, I do not want a dollar of the money, and I will be ready to waive this proceeding, but when the case rests

upon such a basis as we have contemplated, and when so much is involved, I ask that time be granted, and that a committee be appointed to look over the matter with Mr. McIntyre.

Gov. Morehouse: The question before the house is to adopt the resolution. Does the committee accept Prof. Sanborn's amendment? You will pardon me for saying a word from the Chair. The opinion of Mr. McIntyre is an opinion that every lawyer can endorse. What little knowledge of law I have, I endorse that opinion. It is correct; there is no question about that, and from the investigation made by Mr. McIntyre everything does appear to be regular. The journal shows only that the House amendment was offered to the Senate bill number 95 and was agreed to. There is no question about that; and then the House Journal shows the bill as amended and passed the House. That is right and correct; that is the usual way bills go through either branch of the legislature. But the journal of the House does not show the amendment—it says it was agreed to and passed the House and went back to the Senate as amended, was agreed to in the Senate—and that is all the journal shows. Everything on the journal says that the bill was regular and that we are entitled to the $8,000. There is no question in my mind in the world about that. I believe we would get it. The question is, was the $8,000 honest and fair and intentionally left in by the legislature? That is the question for us to determine as citizens of the State of Missouri, outside of our official acts as members of this Board of Agriculture.

Well, then, if the position that I have taken, and the position that other members of this Board have taken, in saying that the bill as illustrated by Dr. Laws is correct, it appears to me there is no doubt upon the mind of any gentleman but that the legislature did not intend to appropriate this $8,000 to the Agricultural College farm, because the amendment of the House evidently went to Engrossed Senate bill instead of to the Enrolled Senate bill, and struck out the words after "for in the sixth line" and that was not the amendment submitted to the House and passed the House and was concurred in by the Senate, as I have said before. This is my opinion, and I can account for it in no other manner. They enrolled from the printed bill instead of from the engrossed bill and left the $8,000 item in, because in the printed bill the $8,000 is left in. Now that is the way that mistake occurred.

Prof. Sanborn: I will not take any more time, but will say that it will be more satisfactory to appoint a committee. I would like to have no shadow of a doubt about the correctness of this matter and think the committee going over there and holding a consultation with Mr. McIntyre would be the surest way of getting at it. It is barely possi-

ble that the legislature acted upon the printed bill. I say there is a bare possibility that a mistake of this kind occurred and I prefer to have the committee go there.

Gov. Morehouse: The question before the Board is on the resolution.

Prof. Sanborn: I hope it will be voted down for the reasons I have just stated, but if I must vote on present evidence shall have to vote for it.

Dr. Laws: If there was a shadow of a doubt in my mind as to the genuineness of this manuscript bill laying before us, I would also hesitate about this matter. But as it stands before us it seems to me that if the committee went to Jefferson City they could get no more definite information than that the Governor has brought with him here. The original documents are precisely the documents the committee would have to examine. If they were not here there might be reason for a committee going there. Accepting the original documents, I see no obstacle in the way of immediately acting on the resolution offered by Judge Emerson. I see no adequate reason for further delay in this matter. When we have acted upon this I wish to make a motion to the effect that the letters of Mr. McIntyre and Attorney-General Boone be spread on the minutes of the Board. They will thus be valuable in elucidating the matter before the public. I look forward to the time when this cloud will be dissipated.

Mr. Leonard: I hope the motion of the gentleman will not prevail. I feel that the Board are under obligations to you, Mr. President, for the evidence you have brought here. I think every member ought to be convinced of the truthfulness of the evidence. There has been too much said already on this subject. I believe the failure of the Board of Agriculture to settle this matter at this meeting will work harm rather than good to all concerned. Therefore, I hope the suggestion offered by the gentleman will not prevail and we will settle this question and not have to take it up again.

Mr. Doud: I would like to ask if this is an amendment to the motion made by Mr. Leonard last night?

Gov. Morehouse: I understand, Mr. Leonard, that your motion was to dismiss the mandamus proceedings?

Mr. Leonard: Yes, sir; it was that the Secretary be requested to dismiss the mandamus proceedings. I am perfectly willing to withdraw that motion in favor of the motion of Judge Emerson. I will be very glad to substitute his for mine.

Gov. Morehouse: Let the minutes show that the motion of Judge Emerson was substituted for Mr. Leonard's.

Judge Emerson: He can withdraw his motion.

Mr. Leonard: I will be very glad to do so.

Gov. Morehouse: The Chair will state that by common consent it would be taken as substituted. It is not really necessary to withdraw the other motion unless some one desires it to be accepted in lieu of the other motion. I will take the vote this way unless there is some objections. It so stands.

The question is—

Mr. Doud: I would like to have the ayes and noes taken.

The roll was called with the following result:

Dr. Laws, aye; Cowan, aye; Leonard, aye; Fulbright, aye; Smith, aye; Rippey, absent; Doud, aye; Emerson, aye; Sanborn, aye; Harmon, aye; Coleman; aye; Potts, aye; Gov. Morehouse, aye. Carried unanimously.

Judge Emerson: I was going to suggest before the vote was taken that inasmuch as there has been so much publicly said in regard to this matter, that perhaps it would be only proper that some statement embodying the facts on which the Board acted before, the simple facts governing their action concerning this mandamus proceeding, some final statement be given as to why the Board acted this way and the other way, be made as publicly. The Board might have Dr. Laws to make such a statement in a succinct way and have those facts published, so that the people of the State may understand why the Board has seen proper to act differently to-day, without casting any reflection upon the action of the Board at a former meeting.

Gov. Morehouse: Your resolution covers that ground to some extent; but do you make that as a suggestion?

Dr. Laws: I was wishing that the letter of Attorney-General Boone read to us last night, and also the letter of Mr. McIntyre, addressed to the President of the Board, be spread on the minutes in full, *in extenso*; and also that the brief of Mr. McIntyre to which attention was directed, be placed permanently in the book of the records of this Board. It is for the purpose that these matters may be exhibited so that persons wishing to see them may do so without inconvenience or delay. They will also be valuable records to preserve.

Prof. Sanborn: I suggest that they be published in our annual catalogue.

Mr. Coleman: If you bring in the brief, then the evidence of the other side will have to come in also.

Dr. Laws: I will withdraw my portion of the motion regarding the brief; it will make it too long.

Judge Emerson: Second the motion.

Mr. Doud: I would like to offer an amendment to the motion to the effect that all the letters pertaining to the subject of the mandamus proceeding, from State officers, communications from the members of the Legislature that have been written to members of this Board be incorporated in the proceedings of this Board, and that the stenographer be instructed to make a transcript of the notes taken at this meeting, and the entire proceedings be published in pamphlet form, and each member of the Board be furnished with a hundred copies of the proceedings.

Gov. Morehouse: The Chair is of the opinion that the amendment is a little extensive. If the gentleman would move to amend the first part of the amendment, that all communications enumerated be placed upon record, and then afterwards make a resolution that they all be published in pamphlet form, it would be correct.

Mr. Doud: I accept the suggestion that all the letters on the subject of the mandamus be incorporated in the official records of this meeting.

Gov. Morehouse: The letters are on file, I presume, and can be procured.

Mr. Doud: The members have them.

Mr. Cowan: The amendment was not seconded, and therefore was not in order.

Dr. Laws: The purpose of the amendment was a distinct act to spread on the records of the Board at another meeting, I would think the proper way to do would be to keep the matters distinct to that extent.

Gov. Morehouse: Is there a second to Mr. Doud's motion.

Mr. Doud: I want to say a word. The only object I had was that I thought it only fair to show the whole matter and not to spread only a part of them on the records. Without such an amendment I could not vote for the motion, but I would like to vote for it. I would like for the records to show clearly why we rescind the former action of the Board.

Gov. Morehouse: It occurs to the Chair that this Board has this morning unanimously agreed to everything contained in all these letters; there has been no dissenting voice in regard to the letters that have been read. It occurs to the Chair that Dr. Laws' resolution is a very proper one, and the amendment offered by the gentleman is in order; the object of Dr. Laws in introducing his resolution was to place on record before the world the reason the Board had reversed the action taken at a previous meeting. The Board has acknowledged everything that could have been said by the letters, and it occurs to the Chair that

it is not necessary, if we all agree that what is contained in these letters is correct, to offer that resolution. These are the facts in the case, but it is entirely in order and proper to place the letters on the records of the Board.

Mr. Coleman: I think the resolution of Judge Emerson covers the entire case. I conceded some things in that resolution that I did not think I would do when I came here, but the manner in which Judge Emerson stated it, and to make the action a unit, I will vote for it. I want to vote for that that will be for the greatest good of the institution. I think that resolution covers the whole ground. He leads me to believe that they had sufficient ground at the time, and that light has been thrown on it since, and the Board sees fit to withdraw the mandamus. Now it appears to me it is unnecessary. I think there are some things in the letter of Mr. McIntyre's that is wholly irrelevant. I presume it will be best for me not to state what Mr. McIntyre told me in person, but it would upset that very opinion. He looked at it in the light of a lawyer, and says as a lawyer that the bill is correct from its inception throughout. He did not take into consideration the questions we are discussing, and says from his standpoint there was nothing irregular in the passage. We do find something irregular in it, and therefore we rescind the order. Looked at from the way I do, it seems to me to be best to let the matter drop right where it is for the resolution of Judge Emerson covers it all.

Mr. Leonard: When I accepted Judge Emerson's resolution I did it with kindness and with a view to ending the discussion here. If there is a gentleman here that does not believe that the Board has a legal right to the $8,000, I do not know who it is. None of us doubts that. There has already been too much said and written about this, and I do not see the use of bringing it up again. I came here with the idea of settling this matter at this meeting. I think it is for the good of the institution, the State, and all concerned to settle this matter here. I do not think it is right for the letter to appear on record. If it is going on record I do not believe we can have such an amicable settlement. I do not think it is fair and right. In accepting the resolution of Judge Emerson I gave up some things that I did not think I would. I am glad you wrote that resolution, Mr. Emerson.

Mr. Harmon: There has been no word against any member of the Board who acted upon the resolution. They did their duty according to the hour; and it our duty to do what we think right according to the requirements of the hour. It is our duty to place every member of the Board and the committee of the Legislature in fair and full exonoration before the people of the State. I meant to call the matter up as soon

as possible, but Judge Emerson brought it up in such a way that it seems to have met with the approbation of all the members.

Gov. Morehouse: The question before the Board is the motion of Dr. Laws.

Mr. Cowan: I would like to call for the roll to be called on this question, if it can be called for after the question has been put.

Gov. Morehouse: It is the rule that the roll can be called after the question has been called.

Judge Emerson: I would like to inquire what remains of the resolution of Dr. Laws.

Dr. Laws: The letters of Generals Boone and McIntyre which were read last night.

The roll was called with the following result:

Dr. Laws, aye; Cowan, aye; Leonard, no; Fulbright, aye; Smith, aye; Rippey, absent; Doud, no; Emerson, aye; Sanborn, aye; Harmon, aye; Coleman, no; Potts, aye; Coleman, N. J., absent; Gov. Morehouse, aye.

Secretary announced nine (9) ayes and three (3) noes. The motion was carried.

Judge Emerson: I move the board do now adjourn and go home.

Mr. Doud: Before the motion is seconded there are several matters of great importance to be settled at this meeting. One of them I am more interested in than any other. I move you, Mr. Governor, that the Governor be instructed to investigate the charges preferred against myself by going to Kansas City and notifying the defendant what time you will be there that he may have the opportunity of defending himself, and present such facts as exist, and that the authority be extended to the extent of going over the records of expenditures of money so far as regards the expenses of the different members of this Board and see as to the manner they show that my expenses have ever been unreasonably more than they ought to be. I would also ask that that investigation be had at the Governor's earliest convenience. I make it as a motion, and sincerly hope that there will be not a solitary voice against it. I want it and I am entitled to it. And if I desire it no one should oppose it. I make this request because the Governor is the appointing power in the State and is the proper officer to make the investigation impartially and for the good of the State, and not from any sectional prejudices he may have, because he has the entire State under his protection. I am willing to stand by his decision.

Prof. Sanborn: If you will allow me to suggest, that was already embodied in the original motion.

Mr. Doud: That motion was made and no notification was given me. Governor Marmaduke is now deceased, and as a matter of record I know nothing about it. I want this matter investigated; I have nothing to hide. If he had accused me of being poor, I would have plead guilty; but when he accuses me of dishonesty, I plead not guilty, and asked to be proved guilty if I am not innocent.

Prof. Sanborn: He insists on charging me with having made the assertion. The action was taken by the Board and not by myself.

Mr. Doud. It was acted on the spirit of the letter he showed. He took the letter and handed it around.

Mr. Cowan. It seems to me that Mr. Doud's motion is unnecessary. This Board has preferred charges against him, and the Governor is the only authority that can remove a man from office. It is a reflection upon the Governor to say that he will do it any way, or that he will not do it any way, or that he will act upon insufficient evidence. From my knowledge of the Governor as an individual, I know he will not take any action before informing himself on the subject by careful and patient investigation. I think the motion is an insult to the Governor, and Mr. Doud ought to withdraw it.

Mr. Doud: Mr. Governor, as a lawyer you are aware that proceedings of this kind, if they be just to the defendant, must be regular. The Governor has power to remove for cause only, but he is not clothed with power to investigate charges against members of this Board unless that power is voted to him by the Board, and no member can be removed, such decisions have been rendered in the Supreme Court in this State, unless the defendant has been notified and every opportunity has been given him for presenting his side of the case. If there has been any fairness in this I have failed to find it. It was by a mere accident that I found out about it. Nothing could have astonished me more than his denouncement of me. I hold that the action has been as irregular as irregular could be. I believe my motion to be in order and legally right, and I hope that the gentleman will withdraw his opposition and let this investigation go on. I solicit it from the very bottom of my heart, because I feel that the results will be to my advantage. If it is not and the Governor finds reasons, if that Governor will name to me that my usefulness as a member of the State Board of Agriculture has been impaired, I will take off all the responsibility from his shoulders, and give him my resignation before he leaves Kansas City. I ask this sincerely, and hope the gentleman will not raise further opposition.

Gov. Morehouse: The Chair is not aware of the status in the case except what has been said here at this time, and will now inquire

of Prof. Sanborn what the purport or extent of the matter was as referred to Gov. Marmaduke before his decease.

Prof. Sanborn: You have heard the resolution read. The committee of three looked up the matter and submitted papers to Gov. Marmaduke and asked his action. There are a bulk of letters and papers that had been submitted to the Governor, and he had, I think, given attention to the subject before he was taken sick.

Mr. Doud: I would like to ask the gentleman to state if he knows the extent to which the inquiry was made, and from whom the information was obtained.

Prof. Sanborn: I can not recall all of the names; you can find the details better at the office. There are letters from eight or ten different persons written to the governor. The law requires that the members of this Board shall be elected from practical farmers. Mr. Doud was not a farmer and hence was not entitled to hold his position on the Board.

Mr. Doud: I would like to ask if any any time the defendant was notified of such proceedings against him?

Prof. Sanborn: The notification was not given until after a subsequent meeting, but he was notified then.

Gov. Morehouse: I will say, Mr. Doud, as the Executive of the State, if I understand the status of the case, the resolution already passed covers the case; and before I act I will be warranted in getting all the information I can. I will act just as fully and just as fairly upon the resolution of the Board, which, as I understand, is already in the office of the Governor, as I would act under any resolution the Board could pass here to day.

Mr. Doud: With that assurance I will withdraw my motion.

Gov. Morehouse: I feel authorized to do so. It appears to be my duty, and nothing the Board could say, and no resolution the Board could pass would make it any stronger or any more binding on me to make the fullest investigation.

Judge Emerson: I intended to call attention of the board to a single suggestion in regard to the death of a member of this Board since our last meeting. Governor Marmaduke was a member of this Board, and it occurs to me that it would be proper to have a page next to the title page, set apart as a memorial page to him. I do not know any more proper way of expressing the feelings of this Board. I move that Dr. Laws be requested to draw up some resolutions concerning the death of Governor Marmaduke.

Dr. Laws: I have just hastily penned some resolutions and if you will leave it to me I will get them up in better shape.

Dr. Laws was unanimously appointed a committee of one to write the said resolutions.

Mr. Coleman: I would like to know if this barn out here has been received by the Board or the Executive committee. The contract was let last summer and I would like to know if it has been received.

Mr. Doud: The minutes show that it was accepted as it stands.

Prof. Sanborn: It was left to the Executive Committee to receive it, but it has not been received up to the present, except virtually by Mr. Potts, Mr. Smith and myself, a majority of the committee.

Mr. Doud: I would call for the proceedings of the building committee on the barn if it is in order. Let us hear how much of the money has been expended. The law says that nothing can be accepted without a majority of the Board vote to accept it. I am not sure but believe that the bids were let on the condition that the Board take final action on them.

Mr. Harmon: Is this not a special meeting of the Board, and can these questions be discussed?

Gov. Morehouse: Everything touching the welfare of the Board, the institution, or anything that could come up at any meeting of the Board can be brought up now, as the Chair understands it.

Mr. Coleman: I will state my reason for asking the question. The law places the building of this barn in the hands of the Board of Agriculture. It has been so stated in the papers about the Agricultural College, that money that belongs under another Board entirely is being used there before this barn is received in shape and that two State Boards are trying to build the barn at the same time. I am not calling into question the contract. I was not at the meeting last summer, and have never called it in question. I simply wanted to know whether the barn has been received or not by this Board.

Gov. Morehouse: It has been received, as I understand, by the Executive Committee but not by the Board.

Mr. Leonard: I was a member of the committee and I do not remember of having voted for it. I was under the impression that nothing had been done since the last meeting except that Professor Sanborn wrote to me after the last meeting that he had contracted for some $900 worth of work to be done on the barn. I agree with Mr. Coleman that the acceptation should be had. In speaking of this matter Dr. Yeaman, President of the Board of Curators, told me that Secretary Sanborn asked of the Curators $300 to put in the barn and I want to know by what authority he proposed to do it. As I am one of the Executive Committee, and the matter has been turned over to

that committee, I would like to know what has been done? I did not ever know that the barn had been accepted.

Prof. Sanborn: Mr. Smith will recall that Mr. Potts, Mr. Smith and myself went out to see the barn after it was completed and we considered it all right as far as it went.

Mr. Smith: Mr. Leonard said it did not suit him to go with us and so Mr. Potts, Professor Sanborn and I went out there and we saw that everything was all right and we accepted the barn.

Mr. Leonard: I simply do not remember it now; I have no doubt but that I said it, but I cannot remember it now.

Mr. Doud: I rise to a point of order. Mr. Leonard is a member of the Executive Committee of this board and I do not think there is any law allowing him to give an order of this kind. I do not think his action would be legal.

Gov. Morehouse: That is good perhaps as a fact but not as a point of order.

By request Prof. Sanborn read the minutes of the meeting of the Executive Committee, Aug. 18, 1887. The following paragraph being the one bearing on the question:

"Moved and seconded that the Dean of the Agricultural College be authorized to put it floors and erect towers on the barn at a cost not to exceed one thousand ($1,000) dollars, this amount to be borrowed from funds for tools until the $8,000 be drawn, when the same shall be returned. Carried."

Mr. Coleman: I would like to know by what authority the Executive Committee has to take the money and spend it when the law says the majority of the Board shall decide it.

Mr. Leonard: I do not remember that but I know I am loose in regard to remembering things, but it seems to me that I never voted to expend that money on the barn, when I knew we had already expended all the money we had.

Prof. Sanborn: This meeting, I will state for the benefit of Mr. Leonard, was held at the time of the fair, and he and Mr. Potts, Mr. Smith and myself met and had under discussion the cattle question, and among other things taken up this matter was discussed.

Mr. Leonard: What condition was the barn in?

Prof. Sanborn: The sum was voted conditionally or the Secretary was authorized. The Secretary did not act on the instruction, for he thought it was not best to accept the authority. He did it in the protection of the Board and because he thought it was right.

Mr. Leonard: At that time had the money all been expended?

Prof. Sanborn: The barn was not done but the money was spent in the sense that the contracts were let.

Mr. Leonard: I do not want to go on record as having voted to expend money when I think I wanted to oppose the expenditure of money that we did not have. I don't want it to go on record that I voted to spend money for towers, etc., when we had no money.

Prof. Sanborn: I think I can render Mr. Leonard still further service from the minutes. I will state that he voted at another meeting to accept Mr. Smith's bid to spend the $8,000 when we did not have it.

Mr. Coleman: This matter was not brought up before the Board which met here in November, and I never heard a word of it. Last spring the contract was let for building the barn for a certain amount, $6,000 I believe. It appears that some time in August, two months before the meeting of this Board, the executive committee authorized the expenditure of $1,000, and the matter was not brought up before the regular annual meeting.

Prof. Sanborn: I beg to correct the gentleman. I have no doubt but that he forgot the fact, but I did call the attention of the Board to the $1,000, and stated that I had not spent the money because I did not think it wise. Here are two special records. There can not be an item shown in which I have not carried out the instructions of the Board; and I stand here as Secretary and say that not a place can be found where I acted not according to the law and the instruction of the Board with all due dilligence.

Gov. Morehouse: Have you recorded them in your books?

Prof. Sanborn: Not yet, but have full minutes, and they will be recorded. We are doing the work here which usually employes three or four clerks. We have been busy in getting out the crop reports this season, and this money has given us an undue amount of work.

Mr. Leonard: Mr. McBain was employed by the Board to expend the money for the cattle. In talking with him on the subject he said that the cattle had not been all bought, and he had refused to act further as the agent in the matter. At the time of our last meeting I did not think the cattle had all been purchased, and it seemed that some one ought to take the place of Mr. McBain. I differed with him in some respects. At the meeting I understood Mr. McBain to recommend the purchase of three shorthorns—two heifers and a male. He said he wanted to buy four cattle, one from the Vaile herd, one from the Anderson herd, and two from my brother. I did not understand

that to be the case, and my brother does not so understand it. And so it looks to me that this is a matter that ought to be looked into. We ought to put ourselves into a position to buy the cattle. I would like to hear Mr. McBain on the subject.

Mr. McBain: Mr. Leonard and myself do not agree on record concerning these shorthorn cattle. If you will permit me I will state all the facts in the case. When I undertook to find out about the shorthorn cattle in the first place—no shorthorn cattle was purchased direct by me from anybody—the first thing I examined the pedigree, inspected the cattle, etc. I did recommend the purchase of certain cattle by this Board—two head from Mr. Vaile, of Independence, Mo., at a stipulated price, one head from Mr. Anderson, of Independence, and two head from Mr. Leonard, of Cooper county. These cattle were all closely inspected by Prof. Sanborn and me. We first went to Mr. Leonard and asked him to pick out four of the best animals with pedigrees in his lot. He kindly picked out four which he thought would be the best for the purchase, and submitted the price of $150 each. Pedigrees and prices were put in my pocket and given to Col. Muir, of Independence, who inspected the pedigrees. Mr. Leonard further stated that these were cut prices and not the market value of the cattle. We then visited Mr. Vaile and looked over his cattle and got the price on one heifer and tried to get the price on two. The Seth Ward cattle did not please the committee and other parties, and were not taken into serious consideration. Finally I concluded to look over the pedigrees in consultation with Mr. Muir and I made the report that they buy two cattle from the Vaile herd and two from Mr. Leonard's herd. My report in regard to the bull was rejected. It made no difference to me. I was not making a cent out of it in any way; the exact price paid by me was paid by the committee. I would like to know if the four heifers recommended by me were not purchased—the two from Mr. Vaile and the two from Mr. Leonard?

Mr. Smith: When you made the report to the committee at the hotel, Mr. Leonard was there and made a motion to buy the Bates cattle. And I made a motion to buy two heifers from Mr. Leonard.

Prof. Sanborn: The four were bought.

Mr. Leonard: Do you say that I made a motion to buy two cattle?

Mr. Smith: Yes, you did.

Mr. Leonard: I opposed that motion from eight o'clock in the morning until four o'clock in the evening. I never yielded the point that it was a wise purchase. I cannot conceive how I could have made such a motion. You might just as well tell me that I voted for the

mandamus, If you should tell me that I would tell you I know more about it than you do. I do not think you can make me vote for the mandamus.

Mr. Smith: If you will wait a moment I will show the Board that you opposed the motion to buy the cattle out straight, and I made a motion to drop out the male, and you said I will vote for it, and moved to buy the other two.

Mr. McBain: There is only one more point in the shorthorn business: Now, the question came up directly: "Are these Bates cattle any better in quality than other shorthorn cattle." I answered "No." They were not better individual animals, and if they purchased them they were paying for the pedigree and not for the animals, I said this distinctly; they pay for the paper attached and not for the cattle. I can buy a heifer with just as much individual merit, and often more, for a very much lower price.

Mr. Coleman: How much was paid for the cattle?

Mr. McBain: $300, $250 and $150. The Bates cattle cost the most.

Mr. Leonard: How did the cattle costing $300 and $250 compare with the cattle costing $150?

Mr. McBain: I think one of the cattle is a very fancy animal; the other one falls short of being up to a fancy animal. Mr. Leonard's cattle are up to a very high standard, the quality is good enough as an average, and fully up to the other two.

Prof. Sanborn: Who do you understand bought those cattle?

Mr. McBain: The Board. I made a report in the Board as distinctly as I do now, and told the Board that if they wanted to reject any of the cattle I recommended they could do so. I told Charlie Leonard that I would recommend his cattle, and if the Board wanted to take them they would. I told the same thing to Mr. Vaile and Mr. Anderson. The only thing for me to do was to recommend them.

Prof. Sanborn: I have a letter from Mr. Vaile stating the same thing.

Mr. Coleman: Has the Board ever bought these cattle?

Mr. McBaine: Yes they have bought four, but have never received the two from Mr. Leonard. There was some controversy in regard to the Leonard cattle.

Mr. Doud: I would like to ask the Secretary a question: He said the cattle were purchased, I would like to ask if Mr. Charles Leonard has ever been notified of the fact that the cattle were purchased from him?

Prof. Sanborn: I will reply by reading a letter from him to me.

Mr. McBaine: Prof. Sanborn was not with me on the last trip.

Prof. Sanborn: I wish the Board would take notice of the fact.

Mr. McBaine: I visited Mr. Muir and he advised me and I took his advice to get on both sides of the fence in this question, and I tried my best to get there. Now, I tell you that is just the fact. He wanted me to represent the best families and then to get on the other side and get the best plain breeds. And I did that so as to get every body in a good humor with the cattle.

Dr. Laws: Is a special pedigree of the Bates cattle considered better than any other cattle?

Mr. McBaine: Yes, sir.

Prof. Sanborn: Mr. Vaile said he had never sold one of his imported heifers for less than $1,000.

Mr. Leonard: A little more advertising and we could make a good deal of money on that heifer.

Mr. Doud: The question I asked was, has Mr. Leonard been notified that two heifers were bought from him by the Board of Agriculture?

Prof. Sanborn: Yes, sir.

Mr. Doud: My information was that Mr. Leonard was not notified.

Prof. Sanborn: This is in answer to my letter to him.

Mr. Leonard: My brother is laboring under a misapprehension. For that reason I hoped he would come to this meeting. He thinks the cattle were not bought from him. I remarked to him one day that the Board had bought the cattle from Mr. Anderson and he thinks they rejected his cattle. I thought there was a kind of personal favor shown, and I thought that a thing like that would be wrong. I was not selected to buy the cattle and it was a delicate matter for me to do it when I was not appointed by the Board. My brother said it made no difference whether they bought his cattle not. The letter Professor Sanborn has read is in reply to a letter Professor Sanborn wrote him about the matter.

Prof. Sanborn: This subject must not be confused. The Board purchased the heifers from Mr. Leonard and I notified him that we would take the Duchess of Ravenswood at his price, and here is his answer. I had accepted that offer and written him. There is no use of talking about it. This is his answer. He simply declines to take the price he bargained for and wants another price.

Mr. Doud: Mr. McBaine, I would like to ask you if you ever went to Mr. Sanborn in regard to the Leonard cattle?

Mr. McBaine: Yes, I did.

Mr. Doud: State the conversation?

Mc. McBaine: Mr. Leonard and myself did not agree at all yesterday concerning the minutes of the meeting. I told Mr. Leonard that while I had no feeling in the matter I felt that there was a misunderstanding. He stated, as I knew, that Charlie Leonard was always a great friend of this institution and would give a head of cattle if he was asked. I believe he would have given anything I requested him to give. I knew there was a misunderstanding but I did not know where it was, and I went to Dr. Laws and said there was a misunderstanding on the subject and he suggested to write and find out about it, but I did not do that. I asked Professor Sanborn why the cattle did not come and he said Mr. Leonard had declined to fill the order at the price named but wanted the same price that was paid for the Bates cattle.

Now, this Mr. Leonard said his brother did not understand the matter. I know that if I asked Mr. Charlie Leonard to send a head of cattle here he would give it to the institution. He is one of the best friends of the institution and one of the most honest men and when he said he would sell the cattle he meant what he said.

Prof. Sanborn: Gentlemen do not lose sight of the letter I hold in my hand.

Mr. McBaine: I want to do justice to all concerned, and I wanted to say this in regard to Mr. Leonard. I expect Mr. Abiel Leonard misunderstood the import of the other purchase, but I know I insisted on the purchase of a head from Mr. Leonard, and it was a well laid plan to get the top of his breed. I examined cattle in different parts of the State and was not suited, so I wrote letters to Kentucky; Bates cattle was offered me for $1,000. I was not in favor of going out of Missouri and I could not pay $1,000 or $10,000, not any such prices as most of the cattle was offered me at.

Prof. Sanborn: Here are the prices of the various cattle.

Mr. McBaine: I wrote to a number of gentlemen in Kentucky but could not get a single price on an animal that I considered cheap.

Mr. Doud: I believe that Mr. McBaine recommended $150 each for the cattle purchased from Mr. Leonard. To dispose of this matter, it has already been admitted by the Board that the cattle were bought by the Board at Mr. Leonard's prices; therefore, I move you, sir, that the Secretary be instructed to notify Mr. Leonard that it is the pleasure of the Board that he forward the cattle mentioned by Mr. McBaine, at $300 for the two head. I think he is entitled to that. I believe they are cheap cattle and am satisfied they are worth the money.

Mr. Cowan: I should think if there is any doubt about his not knowing that this would be the best thing to do, and I second the motion.

Mr. Doud: There is no reflection cast upon the letter.

Mr. Harmon: Mr. Leonard is a gentleman of high position in the State and is one of the best short-horn breeders in the State. He has a right to decline to send the cattle if he desires to and if he does so decline, that ought to settle the matter.

Mr. Leonard: It is not necessary to stay here to prove my brother's friendship for this institution. He does not care to sell the cattle; he wants no misunderstanding between him and the Board. But as Mr. McBaine said, he felt that there was a difference between him and my brother and he regretted that the difference had sprung up. I brought this up that it might be settled amicably and satisfactorily. I shall oppose a motion to purchase the cattle as the Board has already purchased them, and I am certain my brother will not be hurt if the Board does not take his cattle.

Mr. Doud: My motion is not to purchase the cattle. I stated as a preamble that this Board had understood from the report of Mr. McBaine that the cattle were purchased, and I made a motion that the Secretary notify Mr. Leonard that it is the pleasure of the Board that he forward the cattle.

Prof. Sanborn: I want to say that I admire Mr. Leonard greatly and consider him a gentleman in every sense of the word. I have received nothing but uniform kindness from him up to the present time. Every where I travel in this State I find that he is held in high esteem. No man to-day holds a more honorable place in my mind than he does. It was simply a business question I asked him; there was no quarrel. I afterwards said to Mr. Abiel Leonard that I proposed to take one from Mr. Cowan's herd and one from his brother's. I regard Mr. Cowan's and Mr. Leonard's as among the two best bred herds in the west outside of the Bates, and I was anxious to get a representative from both herds. And furthermore, before we voted to purchase the the two animals, Mr. Abiel Lenord wrote me that he thought, owing to certain interests of the Board, it would be best to purchase but one from his brother and one from Mr. Cowan. Mr. Potts also made the same recommendation, and I then wrote to Mr. Charles Leonard that we would take the Duchess of Ravenswood. I want to state that he said we would pay $125 if we took four from his herd, and $150 if we took one, and if we took two, I think there was no bargain.

Mr. McBaine: My impression is that Mr. Leonard never said that

we could have them for less than $150. We pressed that upon him, but I do not think he ever conceded it.

Judge Emerson: I would inquire whether as a matter of fact the Board still want the cattle?

Gov. Morehouse: The resolution before the Board is that the Secretary be instructed to notify Mr. Leonard that we accept them.

Mr. Doud: The motion is that the Board has admitted the acceptance of these cattle on the recommendation of Mr. McBaine, and the resolution is that the Secretary be instructed to notify Mr. Leonard that it is the pleasure of the Board that he forward the cattle at $150 per head, as he offered to the Board.

Judge Emerson: The inquiry I am making is whether in the meantime since the Secretary understood that Mr. Leonard declined to send the cattle, have they been supplied from another source? If the Board has all the cattle it needs it will not want Mr. Leonards's cattle, and it is right to disabuse his mind. Perhaps we cannot better do it than to pass the resolution offered by Mr. Doud. The matter still stands open, as I take it, but it is proper to disabuse the mind of Mr. Leonard in regard to his understanding of it, and then we can proceed to consummate the purchase.

Mr. Doud. I would like to ask if it will be in order to have the Secretary to instruct the members of the Board as to what cattle has been purchased in toto, from whom, from where, and at what price.

Mr. Coleman: And how much of the $3,500 is left?

Prof. Sanborn: I can only speak from memory, gentlemen, and cannot give the exact data. Deducting the expenses of travel and other necessary expenses, my impression is that there is but two or three hundred dollars left. In regard to the purchases, there was one of the Vaile herd, a shorthorn, and one Anderson shorthorn; a second shorthorn from Vaile; three head of Jersey cattle from O'Fallon, of St. Louis county; I think five Jerseys from Alvord & Mills, of Massachusetts. These animals are all fairly bred and are the highest selling animals to-day. $517.50 was the price paid. I am glad to say that animals of the breeding of one have since been sold for double the amount paid for her. There was also one Hereford purchased from Mr. Gudgell, of Independence, and three animals were purchased from Mr. F. W. Smith at $200 apiece; one Angus, not delivered yet, from Mr. Rea, of Carrollton. I have never seen the Carrollton heifer nor the Anderson heifer—Mr. Smith and Mr. McBaine purchased them, I think the price was $300. I wish to say in regard to the Anderson heifer that I never saw her until she came into my yard. I am very

anxious to get one from Mr. Cowan's herd and one from Mr. Leonard's herd.

Mr. Leonard: Prof. Sanborn has made some remarks that have made some things clear that I did not understand. I now do remember that the Board did determine to buy these cattle of my brother. I never understood the facts myself. I am glad that I now remember the part I took.

Prof. Sanborn: As far as your brother is concerned, I think he will consider it an insult to ask him to send the cattle. He is the soul of honor, and would think there is a reflection cast upon him. There are two distinct classes of shorthorn breeders. Mr. Leonard was contending for a principle, and upon which we do not agree. He went into the declination deliberately, and I said if it was agreeable to him we will drop it. I should regard anything of the kind as an insult to him.

Mr. Coleman: What did the three Jerseys cost?

Prof. Sanborn: $325, and the four Jerseys cost $517.50, and the shorthorn $150 I think.

Mr. McBain: I would like to ask Prof. Sanborn about the cattle from Mr. Rea. His price was such that I recommended not to purchase the black cattle. I dropped the subject there. I had offered to recommend it for $300, and he objected and said he would not take that, and I dropped the subject and came home.

Prof. Sanborn: He finally came down to $300 and we purchased it.

Mr. McBaine: That is since my connection with it.

Mr. Doud: Mr. Secretary did not answer my question: I asked him to state what cattle were purchased, the price paid for each, from whom purchased, and from where. He failed to state the price and from where they were purchased. I would like to have that part of my question answered.

Prof. Sanborn: $300 for the first Vaile heifer, and $250 for the other, $150 each for the shorthorn; $517.50 for the five Jerseys; $325 for the three Jerseys from Frank O'Fallon, of St. Louis county. I think O'Fallon is the name of the station where he lives; it is a small obscure station; $200 for the one Hereford purchased of Mr. Gudgell, of Independence, and we got three Herefords from Mr. F. W. Smith, of Columbia, for $600.

Mr. Doud: Now I would ask the Secretary what was the expense of getting those cattle here?

Prof. Sanborn: I cannot tell now exactly. The railroad expense was very high at that time. I think the express on the first two was

$59, and on the second two, was $129, on which there was a rebate of $29, making it about $100.

Mr. Leonard: In speaking of the purchase of the black heifer from Mr. Rea, of Carrollton, and the last shorthorn, I do not think the cattle could have been purchased as Mr. McBaine said he refused to act further. I understood that the catttle could not be purchased unless Mr. McBaine was there.

Prof. Sanborn: I understood thoroughly and fully that Mr. McBaine recommended the purchase of the cattle.

Mr. McBaine: I did not recommend it to the Board; on the contrary, I recommended that they would not purchase the black cattle; but I went to visit Mr. Rea, and I offered to recommend the animal for $300, but he refused to let me recommend it at that price, and I never knew anything about it after that, and this has grown up since that time. I suppose he conceded to the terms I asked.

Mr. Potts: If I understand you, you thought it was worth that price?

Mr. McBain: Yes, I would have recommended it if he would have conceded. I told the Board that I would have recommended the black heifer at $300. I tried to get one from Mr. Estill and others for that price, but they would not let me do it. I then sent to Mr. Geary, and his price was much above me, it was $1,000.

Mr. Leonard: In regard to the shorthorn bull, what was done about it?

Mr. McBaine: I do not know anything about the bull. When I was at Mr. Vaile's—I will give you a full history of it—we took Mr. Muir with us, and I recommended the bull for $250, and it was rejected by this Board, and that is all I know about the bull business; do not know anything more about it.

Mr. Leonard: Then I would ask why do you not know something more about it?

Mr. McBaine: Because I have quit.

Mr. Doud: I want to speak in regard to my motion. I think the members are prepared to vote on it now. I have made an estimate of what the gentleman says he paid for the cattle, and deducting that amount from the appropriation of $3,500 would leave about $800.

Prof. Sanborn: I will make a correction. The traveling expenses and other necessary expenses makes it more than he has estimated. There is only about $300 left; I speak from memory.

Mr. Doud: I do not think the traveling expenses could amount to that. But I do not wish to discuss that point nor the point that the cattle were purchased contrary to the law; I wish to discuss the point

'that Mr. Leonard himself stands in the dark concerning the whole proceedings of the Board. I can only reiterate what has been said in regard to the honor of Mr. Leonard. He is the most honorable man I ever met. I know he would far prefer to withdraw the cattle than to have any contention about it. He stands at the head of common breeders of Missouri, and I do not say a word against any other breeder in the State. I think it is due to Mr. Leonard that the Missouri Agricultural Institution shall have his herd represented on the State farm. I hope my motion will prevail, and that it will be the vote of the Board that Mr. Leonard shall forward a representative from his herd.

Dr. Laws: Mr. McBaine has referred to myself as being a party to an interview respecting the purchase of cattle from Mr. Charles Leonard. As a matter of fact we had a reprentative from Mr. Leonard's herd here some years ago, but we had the misfortune to lose it. In a terrible storm and flood it was drowned. I felt interested in having another representative from his cattle. As to his feeling toward this institution, I feel sure that they have never been otherwise than friendly, and I felt that he could be counted on in this case. I made proposition to the Board, which was not a very business-like proposition, but I thought it might answer in this matter. It seems that there was an implied business discrimination against his herd in favor of another herd, and he did not choose to be put to the disadvantage of putting his cattle at a lower rate than was paid for other cattle, the Bates cattle, and I said, half in jest and half in earnest, that it would be well to pay Mr. Leonard just what was paid for the Bates cattle. Of course it was not very business like, but I thought it a good idea. With reference to this institution, Mr. Leonard is an alumnus of the University, and has taken occasion to show personal interest in the affairs of the institution ever since my connection with it, and I suppose before that time. If there is anything this Board can do to relieve Mr. Leonard of a misapprehension, I would cheerfully join in it. And I ask his brother had we best pass this resolution, and if he thinks it best I will vote for it.

Mr. Leonard: I am satisfied that it would be a very great pleasure to my brother to let the matter drop in regard to the cattle, but I know that he would like to be set right before the Board. He would be glad to be relieved of sending the cattle. I think the resolution is very proper, as far I can see, for it leaves it with him. Mr. Doud, state the resolution again.

Mr. Doud: I said, it is the pleasure of the Board that he forward

the cattle. It leaves it entirely with him to decide whether or not he will.

Gov. Morehouse: The question is on the resolution.

The question was put and carried unanimously by acclamation.

Mr. John S. Clarkson who had been appointed a committee to draw up resolutions expressing the sentiments of the Board in regard to the death of Maj. J. S. Rollins, announced his readiness to present the resolutions, which are as follows:

WHEREAS, The State Board of Agriculture has learned with profound regret of the death of Hon. James S. Rollins; therefore, be it

Resolved, That this Board recognizes and realizes in the removal by death of this eminent citizen, the loss of one of the ornaments and treasures of our State, who for half a century shed honor on the State, has been foremost in every enterprise calculated to build up our State and Nation, and whose wise and comprehensive views have been largely embodied in our State and National legislation, as the author of the bill connecting the Agricultural and Mechanical Colleges with the State University, and as the wise, earnest and persistent friend of that College, he is properly held in warm and tender remembrance by this Board representing the great agricultural interests of the State. Himself a farmer, Maj. Rollins was in close sympathy with his brother farmers, who share with every other interest in this common loss.

Resolved, That we tender to the bereaved family of our distinguished fellow-citizen assurances of our earnest sympathy with them in their loss and grief.

Resolved, That a copy of this paper be forwarded to the family of the deceased, and the newspapers for publication.

JOHN S. CLARKSON,
Committee.

Mr. Doud: I move that the resolution be received.

The motion was seconded and carried unanimously.

Mr. Coleman: In regard to whether this law has been complied with in purchasing the cattle and in the measures concerning the building of the barn and the sealed bids, etc., I think from the discussion this morning it is very evident that it has not been complied with. It has been stated by one member of the Board during this discussion that it was impossible to carry out that law. I will state here that one head of cattle was bought not by the Board nor Mr. McBaine, who knows nothing about it, and has not been brought up before the executive committee. I voted for the executive committee to buy these sheep, hogs, etc., but I never voted for anybody to purchase anything without

the consent of the Board. Considerable has been said about reflections being cast upon the honesty and integrity of members of this Board, especially Mr. Smith. I never said one word against Mr. Smith's honesty and integrity, but I did say the Board had no right to authorize Mr. Smith to spend the $8,000. The law said it shall be spent on sealed bids, that is all there is of it. It is very plain. Having these facts, and from the reports, I say the law has not been complied with. I make this simple statement, and if necessary I am ready to prove it. I do not wish to discuss this matter further. I have made no reflections upon any member of this Board. I have simply spoken in regard to the facts of the law, and have not called the honesty nor integrity of any one in question.

Prof. Sanborn: I would like to understand then, who has disobeyed the law. What shall I understand by the remark that the law has not been complied with? The calf was bought by Messrs. Smith, Potts and Sanborn, by the authority of the Board.

Mr. Coleman: I can not see it.

Mr. Doud: I would like to have the report read. Did they vote the right to buy to them? My understanding was that Mr. McBaine was to purchase the cattle.

Mr. McBaine: My business was to pass upon the cattle, not to buy it. I did not recommend the animal that was all, my recommendation was rejected.

Mr. Leonard: Who did recommend the animal?

Mr. McBaine: I had nothing to do with it.

Judge Emerson: We seem to be destroying one difficulty after another by this interchange of views in a kindly spirit. As far as I am concered, I have absolute confidence in the judgment and integrity and proper management of the Dean of the Agricultural College, and I also have confidence that Mr. Coleman has the interest of the institution in view. Those questions of difference have, I think, all grown out of misunderstanding. One person gets one conception and another another, but the misunderstanding will be entirely dissipated if we talk it over kindly and do not reflect upon any body. I would request that Prof. Sanborn explain fully in regard to the purchase of the calf.

Mr. McBaine: I want to say here that the two Waile amimals would have been recommended by me at the time, but on account of the price being more that I thought I ought to pay. I picked the best one of the herd. We examined the pedigree of one of the animals I thought we would buy. The other animal may have been just as good, and I have no doubt but that it was. I may have known at the time but I do not know know.

Prof. Sanborn: I am not going to say it was a direct purchase of Mr. McBaine's, but we looked at several animals in Mr. Vaile's herd and he wanted a representative here and said the price would be amended to $200. and finally he came do to $150. This animal is better than the other one. I believe it cannot be bought for less than $1,000. I will be most happy to relieve the Board of the animal at the price I paid for it. I believe you have an animal that cannot be bought for other than an extravagant sum.

Mr. McBaine: I suppose it was all right.

Prof. Sanborn: It was my understanding that Mr. McBaine was favorable to the purchase. I consulted Mr. Smith and Mr. Potts before purchasing it. I say that there has not been an act of mine in regard to the purchase of these animals and spending this appropriation, unless it is this matter of purchasing this animal, and I thought that was a matter of common understanding, that I cannot prove was done in accordance with the instructions of the Board.

Mr. McBaine: I think it is all right. And probably would have given full consent to the purchase, I may have given it at the time, for I know there were two animals and both were good, but I liked one better than I did the other.

Dr. Laws: It seems that all told we have some fifteen head at a cost of some $3,200. I would like for Mr. McBaine to state, or some other gentleman who understands it, to state what would be the value of that herd at fair market rates.

Mr. McBaine: I cannot answer that question now. I find that breeders are very reluctant in stating the value of their stock. It is almost impossible to estimate what they would be worth. I believe that there is not a single animal in the whole lot that can be bought by a single gentleman for anything like the amount we paid for them. If there is a gentleman here that don't believe that, let him try and he will very quickly disabuse his mind in that respect. You will find that you cannot get them for near the amount that the Board paid for them. There are gentlemen here who thoroughly understand all about cattle, Mr. Cowan, Mr. Smith and others—these gentlemen on the Board are well competent to give you the cost.

Dr. Laws: Is it worth say $5,000?

Mr. McBaine: It is worth at least fifty per cent. more than paid.

Prof. Sanborn: There is a feature that I do not like to have dropped out here. It is the remark Mr. Coleman made in regard to the facts that the act of the Board was not according to law. I say here again that there has not been an act, unless it was this one, that has not been wholly according to instruction. And I say again I am

ready to relieve the Board of this purchase. I challenge attack from any quarter. The gentleman said he did not vote for an individual to buy the hogs, etc., but he voted for the committee to buy them. I will read an extract from the minutes of the April meeting. Reads as follows:

"The next vote taken was for the purchase of hogs—to accept Prof. Sanborn's bid of $250.

"Mr. Coleman: I move we accept it.

"The vote was called and the following was the vote:

"Chair, aye; Dr. Laws, aye; Mr. Leonard, aye; Mr. Coleman, aye; Mr. Fullbright, aye; Mr. Doud, aye; Mr. Smith, aye; Mr. Sanborn, aye. All ayes; the vote was carried."

Prof. Sanborn: I have read from the stenographer's report of the meeting held April 27, 1887, to open and let bids.

Mr. Cowan: What is before this board? I would like to bring up something. We may not be wasting our substance in riotous living but we are certainly wasting our time in useless discussion. I want to offer the following resolution:

WHEREAS, The cattle industry of our country is seriously endangered by the insidious disease of pluero-pneumonia, therefore be it

Resolved, By this Board that our Senators and Representatives in Congress be requested to use their influence to secure the passage of the Miller–Carey bill for the complete eradication of this disease from our country.

Resolved further, That the Secretary be instructed to forward a copy of this resolution to each of our Senators and Representatives in Congress and to Commissioner Colman.

Mr. Harmon seconded it and said it was known as the "Cattle Bill." There was no difference among cattlemen; they all thought there ought to be more and better legislation upon this subject.

Mr. Doud: I would like to vote for the resolution, but knowing the difficulty of passing it in our legislature, I would like to change the resolution and ask each Senator and Representative to support any good bill that might be put forward.

Mr. Cowan: I will say in reply that this particular bill has been passed by the principal cattle associations all over the country and has received almost universal endorsement of the associations. I would rather leave it as it is, I believe we could all vote for it.

Prof. Sanborn: I want to ask for information if the commissioner of agriculture, a member of this Board, is favorable to this bill. It seems to me that it takes it from the hands of Com. Colman and places it in the hands of other parties. The Commissioner is doing all he can

in this regard, and I shall be very slow in taking it from him and putting it in the hands of another party, especially as I know that the Commissioner will push it with vigor and success. There is no use for a new body to handle this disease.

Mr. Harmon: The gentleman is well aware of the difficulty encountered even in this State in enforcing and passing legislation of this kind. When we had the pleure-pneumonia in this State, the Governor gave from his own purse $5,000 to suppress it, and it was a very difficult matter to handle. Now here is a resolution that has been decided upon by all the largest cattle associations of the country, and I desire to see the resolution pass. I fully endorse Commissioner Colman. Missouri has expected a great deal from him, and he has never disappointed their expectations. He has been responsible every time for the full letter of the law being carried out. I would not do anything to take Colman from the Board of Commissioners, but I wish to consolidate the measure so that the Commissioner can not fail to place it before the House of Representatives.

Mr. Cowan: I am perfectly willing for any change in the resolution that would make all the members vote for its passage. As far as I am concerned I would like to see that particular bill pass, but in order to obviate any serious objection I am perfectly willing to have it modified.

Prof. Sanborn: Did Commissioner Colman and Prof. Salmon accept that bill?

Mr. Cowan: Commissioner Colman I cannot say about, but Prof. Salmon opposed it.

Prof. Sanborn stated at length in regard to the question at issue.

Mr. Cowan: I will state that if the Board will give permission to reconsider it again after being modified, I will withdraw it now and the Board can discuss other business in the meantime.

Judge Emerson: I wish to talk a little more about the heifers and the calf. I believe that matter can be settled so that we will hear no more about it through the papers or otherwise. To my mind the matter of $150 is satisfactory, but I believe that Mr. Coleman does not understand it, that is as to the authority for the purchase. I would simply ask here whether any member of the Board or any one else can raise any question as to the regularity of the purchase. I do not mean technically. Was the purchase honestly made, in other words, on the merits of the purchase are there any objections? If there is simply a technical departure that is a different question.

Prof. Sanborn: If you move that Board will not accept the purchase, it will be satisfactory to me.

Mr. Harmon: I will not do that, for I think the Board has gotten a bargain, and I think if we understand each other there will be no difference of opinion in regard to it.

Prof. Sanborn: I feel almost ashamed to get up so many times, but I have been involved in all of these matters and it seems necessary for me to speak often. In regard to the Vaile cattle, Mr. Muir said it was a very superior animal, and Mr. Vaile regards it as worth $1,000.

Mr. Smith: I asked you to make him an offer of $150 on this calf.

Prof. Sanborn: Mr. Vaile has one of the best Bates herds in the world. I told him there was a little difference of opinion concerning the Bates' cattle, and there were objections made to buying Bates blood. He has offered to take back the cattle. When we got the heifer, he then offered the bull at a merely nominal sum, which was nothing like its full value, in order to maintain line breeding with his heifer. Mr. Vaile is wealthy, and did not dwell upon price.

Mr. Leonard: I was and have been decided in regard to the purchase of cattle. I never should have voted to buy them as we did except under the conditions, I felt that we could not buy them as low any other way and get the worth of our money. I voted for Mr. McBaine to buy them with the consideration that not less than three members of the Board be taken with him. In regard to all this talk about cattle, Bates and every other kind, I know whereof I speak, and the man who undertakes to buy Bates cattle for less than $1,000 or $500, he can not do so and get the value of his money. It is as Mr. McBaine said, you will pay that much for the paper. I will tell you that in Saline county we have not the last two years had cattle to average over $60, and yet we have put the best on the market. It is not worth while to talk about the Bates cattle or any kind. When you pay this price you pay for the pedigree and not for the individual merit of the animal. I have taken the grounds, and still continue to believe that better cattle can be bought for less money, and I can prove it if the members of the Board of Agriculture will come to the sale. I believe I can persuade the people of Saline county to have a sale of shorthorn cattle. I don't want it to go out that we have not any good cattle. I never understood that it was my duty to advocate any special breed of cattle. If you go outside of Missouri you will find that very few Bates cattle are sold. Let us go along and in our best judgment say what is the best breed of cattle, and not depend upon the name of the cattle.

Gov. Morehouse: There is nothing before the house.

Mr. Doud: Secretary Sanborn published over his signature in the Kansas City Times that he was willing to take all the cattle pur-

chased at a sharp advance over the price paid by the State. I would like to ask him if he is still willing to take all the cattle purchased at that rate.

Prof. Sanborn: I never made such a statement.

Mr. Doud: Will he be willing to take them at cost?

Prof. Sanborn: I am asked a direct question. This Board went into a systematic and legitimate advertising, and let the contract to purchase the animals, by two gentlemen subject to the executive committee. All that talk about me or somebody else buying the cattle is mere child's play. They were bought by the committee, and I do not accept the question in good faith.

Mr. Doud: This is a legitimate question. He says in his card "I will take all cattle you bring me at a sharp advance of the price paid." These are his words and he cannot deny them.

Prof. Sanborn: I do deny it. I have a copy of the paper here, and I will show him. Mr. Sanborn showed to the contrary.

Judge Emerson: I hardly think the question as to whether the Secretary wants to purchase the cattle is in place. The question is whether the Board has bought the cattle.

Mr. Doud: I mean nothing unfair about it. I take the gentleman's offer as simply a quarantee of his faith in the purchase. And I asked this question to see whether these cattle were as good as those bought by Mr. McBaine.

Mr. Smith: Prof. Sanborn has agreed to take the one he bought himself; he never said anything about buying the others.

Mr. Cowan: Unless the gentleman has something to bring up that is definite, I will introduce my resolution.

The resolution was read again, modified to read any efficient law for the complete eradication of, etc., and when put to the house was carried unanimously.

Mr. Leonard: I will ask Prof. Sanborn if the bull was purchased for the Agricultural College farm or for himself? If I am not mistaken the executive committee agreed not to purchase the bull of that Bates breed.

Mr. Smith: We agreed not to purchase any bull, but not of the Bates breed.

Mr. McBaine: There was an objection to the bull by Mr. Leonard, and I do not know what that objection was.

Prof. Sanborn: It was on account of age.

Mr. McBaine: I do not know why, but they cut it off.

Mr. Leonard: Did you understand that they were not to get a Bates bull?

Mr. McBaine: We rejected it not on account of price nor merit, but because he was a Bates.

Mr. Doud: I move that we adjourn until 2 o'clock.

Mr. Harmon: I want to pass that resolution.

Prof. Sanborn: I would like to have the gentlemen come out to the farm and see the animal in question. I am sure that not a single gentleman would want the animal to go out of the possession of the Board. I think it a great mistake to have it go out of our possession. I would like to have you go out to the farm to see this animal and the others also. We have two or three other families besides Bates.

Dr. Laws: I would like to make a few remarks. From all the knowledge I have, I am impressed with the honesty and sincerity made to carry the law into effect as nearly as possible, by all parties concerned. The other remark is that we are required to make a report to the next General Assembly; that report will go to the public, and then the minutest particulars will be inquired into The Board has not gone into all the details, but before it goes to the General Assembly we can fill up all the particulars.

Mr. Doud: I would like to speak on a question, but I am too hungry now to do it.

The motion for adjournment was renewed and prevailed; the Board adjourned until 2 o'clock p. m.

AFTERNOON SESSION.

The Governor called the Board to order at 3 o'clock, and Mr. Harmon introduced the following resolution:

Resolved, That the thanks of the State Board of Agriculture of the State of Missouri are hereby tendered to Commissioner Colman for his efficient and vigorous efforts to stamp out pleuro-pneumonia, and also in developing the manufacture of sugar from sorghum cane.

Mr. Leonard seconded the resolution.

Mr. Harmon: Commissioner Colman has been the executive officer in stamping out the disease of pleuro-pneumonia, and it now remains over but a few counties of the country. He has also developed

the fact that sugar can be manufactured with profit in Missouri. I think the resolution a very appropriate one.

Dr. Laws: I will repeat two statements Commissioner Colman made to me: He said they had in prospect the complete extinction of pleuro-pneumonia except in a very few limited localities. As to the manufacture of sugar, he said he believed the day was not far distant when we would manufacture all the sorghum we used to export, and he cared nothing for the tariff.

Mr. Doud: It might be well enough to include the names of two other gentlemen who have been conspicuously connected with the manufacture of sorghum. While it is true that Commissioner Colman was the executive officer of that department, at the same time the party who did the work was not N. J. Colman. It was Professor Swenson and Judge Parkinson. I have taken pains to post myself in regard to this matter, and it is a fact that most all of the machinery furnished by the United States Government was ruled out, and the machinery made by Prof. Swenson and Judge Parkinson was adopted, and the experiments were most encouraging. It has been demonstrated that sorghum sugar can be made in this country with great profit. I think it is due Prof. Swenson and Judge Parkinson that some note be made of their names. It is perhaps known to the members of this Board that a resolution is now before the U. S. Senate, or has but recently been acted upon, requesting the Attorney-General to declare void patents issued to Prof. Swenson on the sorghum industry on some of the results that have come out of these experiments showing conclusively that the industry could be properly managed. I think he does not care about the patent, but he wants the people to know that he did it. I think some note should be made of the names of these two gentlemen in connection with that of Commissioner N. J. Colman in regard to this matter.

Gov. Morehouse: The proper way to get the matter before the Board would be to pass another resolution. You might offer a resolu- to the effect that thanks be tendered to the two gentlemen mentioned, instead of only offering it as a suggestion.

Mr. Doud: I will gladly make such a motion if it will be in accordance with the views of the Board. I would not like to have a resolution of that kind voted down. I made the suggestion in the expectation that the other members of the Board would speak upon it. I would move you, Mr. Governor, that a vote of thanks expressing the appreciation of the Agricultural College of the State of Missouri, and of the Board, be tendered to Prof. Swenson and Judge Parkinson for their very able efforts in co-operation with Commissioner N. J. Colman

in bringing about success in the production of sorghum sugar out of cane.

The motion was seconded, and carried unanimously.

Gov. Morehouse: What is the further pleasure of the Board?

Mr. Doud: Mr. Governor, Dr. Laws spoke of this matter being itemized in the report of the Board to the next General Assembly. I wish to correct him in that respect. The amendment of the House to Senate bill No. 95, in section 2, reads as follows:

(Refers to bill).

Mr. Coleman: He is wrong; that is section 3

Mr. Doud: I will refer to section 3 presently. This is section 2. Section 3 of Senate bill No. 95, reads as follows:

(Refers to Senate bill, etc.)

Now, Mr. Governor, the one section says that the Board shall accept the bids, and the Dean shall expend the money. I think the law means that the Dean will be required by law to make out an itemized bill and present it to the General Assembly. Now, I think if there is anything the Board wants to investigate now is the time to do it. I may be wrong, but I do not think we ought to tell the General Assembly what has been done with the money.

Gov. Morehouse: Is there any further business before the Board?

Dr. Laws invited the members of the Board to visit the museum.

Prof. Sanborn: I want to suggest the Mr. Smith and Mr. Cowan have been out to the barn and have seen the animal referred to in the discussion this morning; I wish that they would report their opinion of the animal, and if there is any objection to the Board taking the animal I still offer, as I did this morning to take the animal off the hands of the Board. If there is any objection to be made I want it made now or the animal will have to stand the property of the college.

Mr. Leonard: It seems that before we can take any action, the action of the Executive Committee will have to be rescinded or gotten out of the way in some way. As I understand it, we positively forbade the purchase of the animal of that blood.

Prof. Sanborn: You are in error, there was no action of the kind taken.

Mr. Cowan: As this matter seems to be somewhat in controversy and in order to bring the action squarely before the Board, I move that the action of the Executive Committee in purchasing this animal be approved.

Mr. Potts: I second the motion.

Mr. Cowan: I have been to the barn since dinner and hastily examined the animal, and I think he is well worth the money paid. He

is a much better animal than I expected to see, and we will probably never have an opportunity of buying such an animal again for that amount of money. I do not think the Board should hesitate a moment about taking it. I regard it as an animal bought at an exceptionally low price.

The resolution was carried.

Gov. Morehouse: What is the further pleasure of the Board?

Mr. Leonard: I want to make the following motion:

That the thanks of this Board of Agriculture be tendered to the chairman, Governor Morehouse, for the assistance he has given us at this session of the Board.

Prof. Sanborn: I second it. You put the motion.

Carried unanimously.

Gov. Morehouse: Gentlemen: You will in return permit me to thank you for coming out as cold as the weather was. I believe we have a full meeting of the Board—all the members except two are present—perhaps the fullest meeting this Board has ever had before. The result is as I expected. There had some bad blood crept into the Board; I knew it was growing worse all the time. I did not think it as serious as a great many did, and felt confident that if the Board would get together and thoroughly understand each other, the difficulty could be removed. Consequently, as Chief Executive of the State, whose business I believe is to look after these things, I though it wise and proper to request the President of the Board to call this meeting.

Now, I believe after all that has been said here, that the law has not been strictly complied with and I do not believe it can be strictly complied with, but from all that has been said and done, I do not believe that the State has lost a single dollar, or that there has been any misappropriation of the money, up to the present time by any member of the Board of Agriculture, that is on the matters brought before us here. I am satisfied that the good interest of the State has been followed. I think it likely that ever bit of the law has not been complied with, but it is impossible to do that. Therefore, let me again thank you for the unamimity you have evinced in settling up the matter satisfactorily. I believe the time and the money spent pursuant to calling this meeting has been well spent, and I hope everything in the future will transpire equally as well as the transactions of the sessions held last night and to-day. But at any time if any member of the Board thinks there is anything wrong going on and should so let it be known, I assure you if it comes to my ears that there is anything wrong, I will call the Board together again and see if we cannot adjust it as amicably as we have this difficulty that brought us together to day. So far as

the objects I had in view when I called this meeting are concerned, they have all been accomplished.

Consequently I thank you gentlemen of the Board for coming here in this friendly manner and bringing about this amicable solution of the question so far. (Applause.)

What is the further pleasure of the Board?

Mr. Cowan: Perhaps I am not strictly in order, but I should have said in connection with the resolution to approve the action of the Executive Committee in purchasing the animal in question, that Mr. Smith and I went out to the farm without the knowledge of Professor Sanborn. He did not know we were there nor did we meet him at the farm. I say this to remove myself from the implication that I went there on the invitation of Prof. Sanborn. While I regard the animal as not as good as I have seen, still I regard him as well worth the money he cost the State.

Judge Emerson: I want to make a suggestion that forces itself upon my mind. The idea has rather developed on me while we have been having this talk over matters in controversy—the difficulty growing out of the purchase of this animal. It rather occurs to me that the wide differences of opinion can be grouped or comprehended better by taking into consideration some of the suggestions made in private conversation with different members of the Board. It appears to me that the difference of opinion has not been in regard to the honesty nor fairness of the purchase, but perhaps of the reasonableness of the price paid and the particular character of the animal purchased. My impression was, from the nature of the discussion heretofore, that the difference arose rather to a question of good faith regarding the extravagant price paid, or perhaps something worse. The gentlemen who differ so widely in opinion regarding the animal reached their conclusions under entirely different conditions. In other words, it turns out to be a difference of policy and not of good faith. It is as to whether the Agricultural College farm should adopt a policy of breeding animals of any particular type, or whether we should breed fancy animals or animals of common breed, or whether the policy pursued should be put in practice throughout the State among the farmers. It would probably be taken up by some of them, but perhaps some of the farmers could not or would not want to adopt the method.

Now, to my mind it is simply a question of policy. The persons who favored the breeding of animals of common breeds would naturally think that purchasing animals of fancy breeds at three or four times the prices paid for other animals would be very extravagant. I can very well see how they would think this. But this does not involve

the question of good faith or honesty, so my impression is that while all of these purchases have been made in good faith, still I think it is a question that the Board might be considering quietly in the meantime as to what permanent policy should be pursued. Whether to adopt the policy which now seems to prevail as the best one, or whether to adopt the other experiment of breeding other class of animals will be the best for the State. Of course we want to bring about the best results to the State and the College, and I simply make this as a suggestion to call attention to the fact that after all the differences of opinion do not arise from a question of fraud or bad faith, but simply as rather a question of policy as to what kind of animals to purchase, and consequently having the matter considered quietly from time to time whether we maintain the present policy or whether we shall adopt a different one, or perhaps experiment on both classes of animals, and have the fancy breeds and the common breeds at the same time. It is a matter that might be thought about, and in course of time settled upon something that would be the permanent policy.

Mr. Doud: Mr. Governor, we have present with us to-day, Mr. M. W. B. Harmon, of Nodaway county, who holds a commission signed by the Governor as a member of this Board, and I move that he be formally enrolled as a member of the Board of Agriculture.

Gov. Morehouse: I supposed the commission from the Governor was sufficient. You have heard the motion.

The motion was carried.

Mr. Leonard: I suppose we are about ready to quit now, and I feel like I am. Inasmuch as the occasion on which we have assembled here has had a wide circulation, I feel that it would be a good idea if the results of this meeting could be as widely circulated. I would like to see a copy of the proceedings printed and furnished to each member of the Board, so that when people asked what was done at this meeting, we could show them the proceedings as published

Prof. Sanborn: The Secretary has a better idea of the finances than the other members, and I will say that these meetings have been a severe tax upon our resources, of which we did not have too much to begin with. I think the minutes of the last meeting cost the Board about $60. The proceedings are longer this time than they were then. I do not wish to oppose the motion for I think it a very laudible one. I have in my pocket now articles from different papers saying that money appropriated to other departments have been misappropriated by this Board, etc. These, and other articles in the papers, are full of errors and misrepresentations, and they are scattered all over the State. The same end may be reached in a less expensive way it seems to me.

However, I do not wish to oppose Mr. Leonard's motion; it has a good end in view.

Mr. Leonard: If it will cost too much money, I withdraw my motion.

Mr. Doud: I would like to ask how much the proceedings would make; how many folios?

The stenographer answered that it was impossible to tell exactly, but it would be a good deal.

Mr. Cowan: The same object could be accomplished in this way, and without additional expense: each member could take the proceedings, after they were written by the stenographer, and have the newspapers in his vicinity to copy it. Almost any paper would do so gratis, and it would be copied in other papers and reach a wide circulation. I could take the proceedings to Holt county and get it published there gratis, and all the other members could do the same thing in their counties.

Mr. Doud: The idea has just occurred to me that as this report of the Secretary is required to be published in the annual report of Board, why could not a copy of these proceedings be written by the stenographer and be sent to the State Printers, who could put it in type and send advanced sheets to the members for circulation. It will cost almost nothing, and we could get the advanced sheets in a few days.

Mr. Coleman: I think that would be almost impossible from the fact that there are several other reports in the hands of the Public Printer, and until this report went in for publication, they would not like to set up one form and have to keep it up three or four months or have to distribute it and set it up again. That would not do at all.

Gov. Morehouse: The report contemplated would not embody the report of the proceedings of this meeting.

Prof. Sanborn: Your remarks cover the vital points at issue, that you come here and found everything all right.

Mr. Leonard: I do not think that will exactly do; he did not find everything all right, he made it all right.

Prof. Sanborn: I did not mean to narrow it down to that, but I took his full statement that things are all right.

Mr. Leonard: The Governor's statement I want to go out. but to say that he came here and found everything all right would not suit me.

Gov. Morehouse: What is the further pleasure of the Board?

Mr. Leonard: If there is no further business before the Board, I move that we adjourn.

Prof. Sanborn: The question has not yet been settled as to how

much of this report of the Secretary shall be published. The Secretary does not like to take the responsibility of deciding.

Mr. Doud: I move that the entire report be published.

Judge Emerson: You do not mean at the expense of the Board?

Mr. Cowan: I move that it be left to the discretion of the executive committee.

Mr. Coleman: How does that executive committee know what we want any better than the Board does? If we want to spend $100 we can have the report published if the Secretary wants to have it printed.

Gov. Morehouse: For my part I not see the necessity of having it printed at all.

Mr. Doud: My motion contemplated its becoming a part of the Secretary's report.

Prof. Sanborn: The reason I raised that point is that the Secretary's report is usually under his control fully, but as issues have been raised here that involve others, the secretary raised the point because he did not care to decide as to what should be printed and what should not be printed for fear of the question being raised that he published what he wanted to, and left out other parts at his pleasure. If it is left with the Secretary to publish the proceedings, he shall certainly condense the proceedings as he thinks best. I merely called the attention of t e Board to the expense that would be attached to publishing the entire proceedings. But if it is left to me I shall condense the matter as four-fifths of the proceedings is idle talk, and not one-fifth, or perhaps one-tenth of it is germane to the subject. (The Secretary published all that the stenographer furnished.)

Judge Emerson: It seems to me that we should avoid the expense of publishing needless matter and I think it would be best to have some member of the Board make a synoposis that will embody all the points at issue and have it published as the proceedings of this meeting. Then persons reading it would be able to get some impression of the actions of the Board. I would propose that Dr. Laws would make a succinct synoposis to go to the press as a matter of news. This will cost the Board almost nothing and would reach the desired end. It seems to me to be the best way of getting at it.

Mr. Leonard: I renew my motion to adjourn.

Mr. Doud: I thought my motion was seconded. It was that the proceedings of this meeting be made a part of the Secretary's report.

Gov. Morehouse: I understood that it was not seconded.

Mr. Doud: My motion was that the proceedings of this meeting be made a part of the Secretary's report and as such be published.

Mr. Leonard: You do not mean to have every word of it published?

Mr. Doud: If a man shall get up and say "and, and, and," I do not care if all three of the works are not put down, but I mean for it to be a verbatim report.

Mr. Leonard: I would like to see a full report made of the transactions of the Board at this meeting, but I would not want all of it published.

Mr. Coleman: I think the least of it that is published will be the best.

Adjourned *sine die*,

J. W. SANBORN, Secretary,

Miss Laura Matthews, Stenographer for the occasion.

A CONDENSED STATEMENT.

In the interest of those who will not care to wade through the long report of the stenographer's of the Board meeting which attracted so much public attention and which is given in order to throw full light on the subject, the following compact statement of the action of the Board is quoted from the Columbia *Statesman*. The Secretary has read it carefully and finds it correct:

STATE BOARD OF AGRICULTURE.

THEIR COLUMBIA MEETING—ALL MATTERS AMICABLY ADJUSTED.

The Board consists of the following members: *ex-officio* members: Gov. A. P. Morehouse, and W. E. Coleman State School Superintendent, both of Jefferson City; Pres. S. S. Laws, and Prof. J. W. Sanborn, Columbia, Secretary. The corporate members are: Jos. A. Potts, President, Mexico; Abiel Leonard, Vice-President, Marshall; Hon. N. J. Colman, Washington City; J. R. Rippey, Lancaster; Judge J. W. Emerson, Ironton; Judge J. H. Fulbright, Lebanon; B. O. Cowan,

New Point; F. W. Smith, Columbia; M. F. Doud, Kansas City, and M. W. B. Harmon, Pickering—all present except Col. Colman and Mr. Rippey.

The Board convened in the Agricultural rooms in the Scientific building on last Tuesday night, and adjourned on Wednesday afternoon. The meeting was called at the instance of Gov. Morehouse to investigate and possibly settle the differences between members of the Board and pending proceedings relative to a mandamus against Auditor Walker for $8,000 thought to be due the Agricultural College, and other matters of public concern.

The meeting was called to order by President J. A. Potts of Mexico, who at once asked Gov. Morehouse to preside over the meeting.

Gov. Morehouse, on taking the chair, stated that he had seen with regret that public differences existed in the Board. These he hoped to see amicably adjusted. He expressed a great interest in the Agricultural College and stated that he had always voted for liberal appropriations for the University and for appropriations for the Agricultural Department.

At this point the speaker was interrupted by the announcement that a committee of students, represented by Mr. Meyers of the Law Class who in behalf of the students of the University invited the Governor to repair to the Chapel and meet the students there assembled.

This was done and speeches followed. The Governor again called attention to his friendship for the University and congratulated the young men on their exceptional advantages. As the pride and hope of the State he hoped they would be true to their opportunities. Prof. Coleman and Mr. Leonard made some remarks. Prof. Sanborn and Capt. Kneislay were called for but declined.

On return to the Board room the Governer invited the members to present there business.

Mr. Leonard moved that the Secretary order the dismissal of the mandamus proceedings against Auditor Walker for $8,000.

Prof. Sanborn objected to a vote being taken that night, inasmuch as Mr. Cowan had failed to make connections for the afternoon train, but would be here in the morning. He therefore moved an amendment to Mr. Leonard's resolution to the effect that the vote be postponed until 9 a. m., the following day. The amendment was adopted.

The consideration of the equity of the case was opened by Mr. Leonard. Messrs. Coleman and Doud participated, but none of the speakers shed any light upon the subject not in possession of the Board at its previous meeting.

Gov. Morehouse then introduced the original enrolled bill of the Senate which showed—as he understood it—that the $8,000 was intended to be struck out by the House Committee. The Governor expressed it as his unqualified belief that the law gave the money and that the Board could collect it. But he thought it would be injurious to the College in which he took a great interest. He thought it would involve the same principle as the acceptance of $5 in gold in the dark for a five cent piece and then on discovering the mistake, retaining in.

Prof. Sanborn stated that the facts given by the Governor were new to him, but that he could not as yet see that it involved any principle not before stated, inasmuch as the House and Senate voted on the bill with the $8,000 in. But if this was not the case it would stand in a new light, and unless it did present some new facts of material importance he could not support the motion.

Dr. Laws then took the floor and from the blackboard pointed out clearly that according to the original manuscript the amendment should strike out all words after the word "for" in the fourth line and that "farms" was "barns" in the original and that "words" was "word"—making it a seemingly clear case of mistake.

Mr. Coleman in his remarks stated it as his belief that the mistake was a clerical error.

Mr. Sanborn stated that he was glad to hear Mr. Coleman attributed it to a clerical error, as it had been publicly stated that fraud had probably been perpetrated. This remark of Prof. Sanborn's was understood to refer to Mr. Coleman's utterances through the papers.

Capt. Kneisley was called upon but threw no light upon the subject.

Prof. Sanborn then asked that Attorney-General Boone's letter be read and also Gen. McIntyre's letter bearing upon the question at issue.

Both letters emphatically endorsed the legality of the claim for the $8,000, and by its terms clearly gave this sum to the Agricultural College.

Gov. Morehouse said these opinions were given on the law and were doubtless correct. He was of the opinion that they were. They did not look into questions not affecting its regularity.

At this point Dr. Laws said it was due to Prof. Sanborn to state that he did not lead off or grab at the appropriation as has seemed to be current. That he personally knew Prof. Sanborn was reluctant to accept it as he believed it to be a mistake, and only when he saw the printed bill did he yield consent, and was the last to fall into line with the law then at hand. After concluding it to be correct his zeal in pur-

suing it was a merit rather than otherwise. The speaker said he would not have seen his way to recede from his former position but for the facts given by the Governor.

Mr. Coleman then stated that he proposed to show in the morning that the law had not been complied with.

Judge Fulbright said it was not possible to advertise for every hog, sheep and steer bought, as it would require every dollar appropriated to pay the expenses of members if the Board should be called together to accept each sheep, or hog bought.

The meeting was then adjourned to meet at 8:30 Wednesday morning.

WEDNESDAY'S SESSION.

A personal controversy was indulged in—Mr. Doud asserting that Prof. Sanborn had filed charges with the Governor against his character with the request that the Governor remove him from the Board.

Prof. Sanborn's reply consisted in reading a unanimous vote of the Board ordering an investigation of his character, legality of his membership and justness of his bills against the Board, and that the evidence be submitted to the Governor with request that he take action.

Judge Emerson then introduced the following resolution as a substitute for the one moved by Mr. Leonard at the previous session:

"This Board expresses its opinion that the act of the Legislature approved March 31, 1887, appropriating money for the Agricultural College and Farm, as printed in the session acts, does by its terms, appropriate the "eight thousand dollars," now the subject of the mandamus proceedings pending in the Supreme Court; and that the majority of the Board who authorized said mandamus proceeding had reasonable grounds for such action, based upon the information then possessed by them—yet, nevertheless, on further information, since obtained, there appearing to be substantial doubt as to whether said "eight thousand dollars" item was intended to be appropriated by the Legislature, and as to whether said item was not in fact intended to be stricken out by the House amendment, this Board wishing to avoid the appearance of accepting or using any money not fairly and fully intended to be granted for the use of said Institution, hereby de-

clines to further prosecute said mandamus proceedings, and directs their dismissal, and will await the further action of the Legislature of the State, trusting that it will, in the future, renew said grant, with others sufficiently liberal to appropriately equip the State Agricultural College and Farm."

Prof. Sanborn believed the matter to be of too much importance to hastily throw it over, inasmuch as our legal right to it was accorded by every one.

We have able counsel employed who have declared the bill regular in all respects, and it is due ourselves, the attorney and the public that we be not precipitate in this matter. I favor a committee of three, continued the speaker, to proceed to Jefferson City, and with Gen. McIntyre, to go over the case and see definitely how it stands, and locate the point at which the error occurred, especially as fraud has been intimated. I believe the Governor's version is correct, and shall act in accordance with it if brought to that alternative, but much prefer a more thorough analysis of the case than we now have.

The vote was taken, and Judge Emerson's resolution was adopted by a unanimous vote.

The remainder of the morning session and all of the afternoon meeting, was taken up by miscellaneous resolutions and discussion of the propriety of Secretary Sanborn's course in applying the law granting the money.

By request of the Board, J. S. Clarkson read a resolution respecting the death bf Maj. Jas. S. Rollins, which was adopted.

A resolution introduced by Mr. Cowan was adopted, instructing our Congressional delegation to support a measure looking to the eradication of the disease of pleuro-pneumonia from the country.

Also a resolution read by Mr. Harmon was passed, tendering Commissioner Colman a vote of thanks for his good work in the sorghum sugar investigation, and for his efficient efforts to eradicate pleuro-pneumonia.

EVENING SESSION.

The battle on Prof. Sanborn's actions in putting into effect the law appropriating money to the Agricultural College Farm was then begun by Messrs. Leonard and Coleman, and continued intermittingly during the session.

Mr. Coleman wanted to know if the barn had been accepted, and if so, by whom?

Prof. Sanborn showed from the records of a former meeting, that

it had been left to the Executive Committee, and that it had been accepted by them.

Mr. Leonard desired to know who purchased the Bates cattle and paid such prices.

It was shown that the Board let to Mr. Turner McBaine the contract—Mr. Leonard voting for him—and Mr. McBaine being present stated that he viewed the cattle and recommended them to the Executive Committee. He stated it as his belief, that they were purchased for less than their value by about fifty per cent., and for less than a private party could buy them.

Mr. Sanborn then showed from the records that Mr. Leonard voted for the purchase of these heifers as a member of the Executive Committee—all of the committee voting for the purchase. Prof. Sanborn also had in his possession a letter from Mr. Vaile, from whom a Bates heifer was bought, stating that he had never sold one of these heifers for less than $1,000; that he put a nominal price on her for the College, and was ready to take her back at the purchase price.

Mr. Coleman then said he had never voted for any man to buy cattle or hogs, but voted to leave it with the Executive Committee to make the purchase.

Prof. Sanborn showed from the stenographer's report, written by her with a typewriter, of a meeting held in April, 1887, that Mr. Coleman's name stood "yes" on the vote to accept J. W. Sanborn's bid for the purchase of hogs. He also showed your reporter like votes for cattle, sheep and other bids.

Other points of like tenor were raised by these gentlemen, but each was promptly met by the records which show that the gentlemen were not familiar with their past actions in the Board.

Prof. Sanborn then stated that in every particular he had followed the law and the vote of the Board, and he now challanged any one to mention a point wherein he had failed to do so.

Mr. Leonard learning of the purchase of a Shorthorn bull challenged it.

Mr. Sanborn replied that it was by agreement of the Executive Committee, and was bought for a mere fraction of its value, and that he would at once furnish a party to take him. That while he contended that the purchase was by a fair understanding, he would not insist upon it. Therefore, if the Board desired the animal, they must take him at once. That he considered the animal worth $1,000, and that Col. Valle regarded it much as a gift, the animal being a fine Bates bull.

Messrs. Cowan and Smith, both celebrated breeders, went out to see the bull, and on returning, Mr. Cowan stated that he was a fine animal, and worth much more than was given.

The bull was accepted without a dissenting vote.

On motion of Mr. Leonard, a vote of thanks was tendered Gov. Morehouse for the interest he had manifested in the matters before the Board.

In response th · Governor thanked the members for their hearty co-operation, and stated that his purpose in calling the Board together had been accomplished; that he was satisfied that good faith had been observed in the management of the funds. That the law in some particulars might not have been literally carried out; that he regarded the law of such a character that it was not possible to carry it out to the letter, but that so far as his knowledge extended, he was convinced that the spirit of the law had been obeyed faithfully; that there had been no misappropriation, and that the State had met with no loss.

The question came up concerning the publication of the proceedings of the meeting, and a general discussion followed. Some members advocated a full report, others only a brief synopsis, while others were of the opinion that the less published the better. The Secretary stated that he desired to act fairly and impartially in the matter, and therefore departed from his usual custom of following his own judgment, in order not to be misunderstood, and would act upon vote of the Board.

Mr. Coleman expressed a decided conviction against it appearing in the 17,000 copies of the Board Report to be distributed over the State.

No action was taken on the matter, and the Board adjourned *sine die.*

MEETING OF THE EXECUTIVE COMMITTEE.

COLUMBIA, MO., April 10, 1888.

A meeting of the executive committee of the State Board of Agriculture was held at Columbia, Missouri, April 10, 1888, with the following members present:

Mr. J. A. Potts, President.

Mr. F. W. Smith.

Prof. J. W. Sanborn, Secretary.

Voted on motion of Mr. Smith to build a silo and root cellar for experimental purposes.

Moved by Mr. Smith that the Dean be instructed to build a fence around the eight acre field used for experimental purposes, and to grub up the stumps and brush on one acre of the same. Carried.

Voted on motion of Prof. Sanborn to use a sum not exceeding $250 in putting stalls in the new barn for experimental purposes.

Voted to put in track for horsefork at the expense of the tool account.

Voted to call a meeting of the Board in June.

Adjourned.

J. W. SANBORN,
Secretary.

INSTITUTE MEETINGS FOR 1887-8.

The following brief review of the Farmers' Institute meetings, held by the Board during the winter of 1887 and 1888, embodies, with few exceptions, only the discussions, while the papers presented and addresses will be found in another part of this volume:

MEETING AT NEW LONDON.

The first meeting of the sixth series of Farmers' Meetings was held at New London, Ralls county, December 20, 1887.

A blinding snow storm greeted the Board and prevented a morning meeting.

The afternoon session was opened in the midst of a driving storm, yet a fair audience was present. As the idea of an evening session was, owing to the inclement weather, abandoned, the afternoon meeting was crowded with talks without an opportunity for questions or discussion.

Secretary Sanborn opened the meeting by answering a call to state the work of the State Agricultural College.

He said the Agricultural College was organized by act of Congress of 1862, which gave 30,000 acres of land to each State for each of its members of Congress. The object of this land grant was "to found at least one college whose leading object shall be to teach such branches of learning as relate to agriculture and the mechanic arts, including military tactics, and not excluding the classics, in order to provide the industrial classes with a liberal education." Thus it was not founded as a farmers' college alone, but as the people's college.

While the leading object was to teach agriculture, or those branches of learning that relate to it, yet farmers are the class that least avail themselves of the privileges of these colleges, although especially invited. Furthermore, we complain because other classes have availed themselves of their plain rights under the law and fill these colleges. While I am deeply interested in the agricultural work of these colleges I can but recognize that the absence of farmer's sons is voluntary on their part and not wholly just for them to complain if others do go to these people's colleges. I am asked what progress we have made. Our college of agriculture was founded in 1870 by our State Legislature which solemnly contracted with the United States to equip and maintain it. It bargained with Boone county, which gave a farm of 640 acres and part of a school building costing in all $90,000. To this the State added $40,000 toward finishing the school building. The State then stopped until last spring, when it added $22,750 to equip the farm and other departments which had been unnamed after the first act of the State in 1870 in State donation. It remained until this year without farm buildings, save a house, and otherwise lacking in equipment until this fall.

None of its land was sold beyond a few acres until 1881-82, hence it was without an income. When the speaker took charge in the fall of 1882 it was miserably off in tools, stock, library, museum, and the fields and pastures were stumpy, bushy and in no condition to be successfully worked.

It now has a fine museum of agricultural objects for class room illustration; a good library of modern agricultural and horticultural works; horticultural grounds of thirty acres, well filled with ample means of illustration in the growth and handling of small and large fruits, nursery stock and garden operations. In addition to this it has a large green house and propagating room.

The farm of 640 acres has had improvements in its pastures, fields and fences, costing two or three thousand dollars, and has carried on experiment work for five years from its own resources as well as its added improvements. For four years it has not received any outside aid, yet its fertility has been doubled and its crops put to the front, its crop of wheat for 1887 being 45 1-2 bushels per acre for all its ground in wheat, or seventeen acres. In the meanwhile its experiments have cost hundreds of dollars annually. This has been done in years of falling prices, and in one of the most serious periods in the history of our agriculture.

Its experiment work I will in part merely mention from memory, as I did not expect this question to be raised. It has carried on trials in

pig feeding every year. Among other things it has shown that about two and three-fourths per cent. of the live weight of a pig is used daily for maintenance fodder, and that if the pig is kept 200 days longer than the needed time for fattening, from forty-six to fifty per cent. more food is used for growth than was necessary. I find that 3.99 pounds of food in many tests will make a pound of live pig; that the larger a shote grows, the more food is required to make a pound of growth; that cob meal finely ground will make as much growth as corn meal; that shipstuff is as good or better food than corn; that a most profound change can be made in the character of the growth of a shote, to the extent of fifty per cent. difference in fat of pigs, a change in the weight of vital organs, hair, etc., by feeding radically different foods—the one very nitrogenous, and the other very carbonaceous. Both pigs may grow at the same rate, yet one shall contain a high proportion of lean and the other an equally high proportion of fat meat.

In cattle feeding it has shown that by feeding albuminous foods with straw and corn fodder these foods can all be used at a very great advantage. Indeed, to the extent of doubling our stock in Missouri from our waste food alone. That clover and corn fodder together are worth as much as timothy hay, pound for pound. That pasture feeding of grain does not pay. That mixed pasture grasses are better than blue grass pastures.

It has shown for years of trials that whole good sized potatoes are much more profitable for seed than many other methods of seeding and probably any other method. That potatoes mulched in dry weather gave greatly increased yields but gave less in very wet years.

It has shown that a soil loses moisture at night and that shallow tillage stops evaporation of moisture.

It has shown that nitrogen is the special fertilizer for wheat on corn, and that it is of little use for corn on the College farm.

It has shown that broad wheels draw much easier on grass sod than narrow wheels and the same holds true of mud roads.

It has shown that corn may be cut up when the ear is going out of the dough state and fodder and corn saved at great gain over the ordinary method.

It has shown that cross-bred corn is more prolific than in-bred corn, and that the stalk can be bred down by selection.

In has made many trials of varieties of wheat and corn.

It has shown that subsoiling is advantageous in dry years, but does not pay on the average.

It found that clover stacked in the field lost 13.7 per cent. in weight of dry matter during the winter.

It has carried forward a system of rotation of crops which shows a very great advantage.

Its system of farming was founded upon science applied to agriculture and has been an experiment, being a radical departure from the methods of the State. It is now shown to be a decided success.

Many other tests have been made, most of which have been given to the public in bi-monthly bulletins.

I should have said that it has graduated several students who are already making a public reputation in agriculture, and has six about to graduate this year.

These meetings are held under the auspices of the State Board of Agriculture, yet they have been mainly supported by the Agricultural College Faculty.

Judge Samuel Miller, of Bluffton, Montgomery county, Missouri, a widely known horticulturist, followed with a talk on apple trees. How to raise them, and how to treat them afterwards.

He said: Any one traveling over our State could not fail to notice that so few orchards are in good condition, which accounts for the slim crops and imperfect fruit of which we hear so much complaint.

That this failure is not due to any one feature of their treatment is patent to every observing farmer.

We know that in the human family a child born of sickly parents will not be like to develop into a strong long-lived man or woman. This rule applies with equal force to the vegetable world. The seed from which apple trees are raised are obtained regardless of source and are the seed from all kinds, from all varieties, whether healthy or not. When one or two years old these seedlings are taken up, cut in pieces, and grafts set to them, boxed until spring when they are set out in nursery rows. The grafts used may be cut from any kind of tree, young and vigorous or old and decaying, according to the varieties desired.

These grafts in a few years are ready for setting in the orchard. Perhaps they pass through the hands of a tree agent, who is not careful about keeping the roots well protected from the air. The trees are planted and that perhaps improperly done. As a consequence, one-half or more never start a leaf, and by fall there may not be twenty per cent. of the original number alive, and such as have passed through the summer alive, are in poor condition to stand the winter.

The owner, discouraged with his "luck," concludes to give up trying to grow apple trees. He is not likely to purchase another lot until one of those persistent tree agents comes around again. The agent describes in glowing terms his new varieties of fabulous worth which

are sure to bear in a few years, are iron clad, etc. The farmer is again induced to make an investment. Possibly he is better informed on the subject of growing fruit trees by this time and has better success.

Now let us take the other plan, select seed from healthy apples grown from thrifty and hardy trees. Sow the seed in rich soil and cultivate well. At one year old take them up and instead of grafting on a piece of the root use the whole stock for each graft. Set them out in nursery rows four feet apart and one foot apart in the rows.

These trees at two years old will be large enough to set out in the orchard and will be worthy of your special care. Your orchard should be rich enough to bring seventy-five bushels of corn per acre and should be cultivated thoroughly to a good depth. Plant the trees 32 feet apart in quincuncial form.

In planting see that the roots are carefully spread out and good mellow soil filled in among them and firmly packed. Place them about two inches deeper than they stood in the nursery row. The hole need not be more than two feet in diameter. If planted in the fall—which I prefer—put a slight mulch around the trees. This should be removed in the spring. Head them at about three feet from the ground and keep them pruned. If this is done there will be no need for a saw. Keep the ground well cultivated and if a crop is grown on the ground let it be such as requires cultivation during the summer, and be sure to manure the land in proportion to the crop you take off.

Don't be in too much of a hurry to have them bear fruit, and don't forget the borers, the greatest enemy of the apple tree.

Get some common fine wire gauze or screening and cut in pieces that will go around the tree and lap at the ends an inch or two. Have it so that it will reach 18 or 20 inches up the body of the tree—one end being against the ground. This will not only keep the borers out but is also a guard against mice and rabbits.

Mr. Waters: Would you mulch young trees during the summer?

Judge Miller: No, sir; stir the soil well, but do not mulch.

Auditor: I have been in the fruit business for fifteen years, and am satisfied that all these fine budded trees are got up to sell, and to cheat the farmers. Reputable fruit tree dealers do not sell the root budded stock. The trees that when set out die, do so because the man who sets them does it in such a bunglesome manner. Many set trees as though they were fence posts, and as though set by a post hole digger or driven in with a sledge hammer.

Auditor: I have set trees and have one set in a sod, a gentian, and it is the healthiest and bears the heaviest.

A long discussion ensued as to whether it was best to graft on the whole root, or a portion of it. The prevailing opinion seemed to be that nurserymen of indifferent reputation used budding on a piece of the root, for the reason that they got more trees for sale at a less cost.

Prof. Taft said he preferred to graft first on the root of a seedling tree; second, on the whole root, and last on a portion of the root.

Prof. L. R. Taft, Superintendent of Horticultural Department of the State Agricultural College was next introduced, and presented a paper on Insects Injurious to Vegetation, which will be found in the body of this report.

Mr. Levi Chubbuck, Agricultural editor of Colman's Rural World, followed with a paper on The Water Supply of the Farm.

This was supplemented by a talk on the water supply of the College Farm by Secretary Sanborn.

Mr. G. W. Waters, a prominent farmer and sheep raiser of Ralls county, was called on to discuss sheep husbandry. The following is a synopsis of his remarks:

It may have been expected that I would have a paper for this occasion on the question of sheep and wool. I have none. The raging storm without rendering the attendance of many farmers at this meeting impossible—so much so, that our meeting, as regards attendance, is a failure—makes me sad, and I would not add to the dullness by reading a dry paper.

A thought or two, however, may be in order, for renewed interest attaches just now to the sheep business. It has got into politics, and we are confronted with the grave proposition: shall we of the United States be able to produce wool in competition with the semi-civilized labor and broad expanse of free grass of Australia, the Argentine Republic, and many other like countries?

To call wool a raw material is a delusion and a snare, and in no sense justice to the skilled producer. And it is just at this point where we farmers want to learn better methods. Of the products of the farm none depend more largely for their instrinsic value on their quality, and this quality on the management in breeding and feeding than wool. As wool leaves the hands of the farmer it passes at once into the hands of expert or skilled consumers or manipulators. These consumers or manipulators detect mistakes and mismanagement. As the fibres are drawn through the fingers of these skillful detectives a period of poverty or a period of exposure to storms is traced in the

lack of tensile strength and elasticity—two points upon which the value of the staple so largely depends.

We may grow a small crop of corn or wheat of good quality on a poor soil but the skilled fingers at once detect the harsh "dead" feel of wool that we have grown on poorly fed or poorly sheltered sheep. Hence, we want uniformity in keep, uniformity in care, and the best of both. By this means we can establish a reputation for uniformity of product.

One other point: Will sheep raising pay on our farms? Not as an exclusive business, but a limited number of sheep—say from 25 to 40 to each quarter section of farm owned—may be sandwiched in very profitably—and herein lies the profit. They glean the weeds from grainfields, feed on pastures too short for profitable grazing with cattle. Then again, the delicious lamb and peas—who but millionaires and farmers can afford such? Perhaps a few words on how to dress a lamb so as to avoid any "wooly" taste would be of some value. With your lamb suspended at a convenient height by the hind legs, the neck is quickly cut across so as to bleed freely. Then at once make an incision in the abdomen about three inches long, and pour in a quart or more of cold water. This absorbs all odors or flavors that would otherwise pass from the entrails into the meat. The wool is perfectly innocent of imparting any taste whatever. We are now ready to take off the skin. Using the knife to rip the hide and get a start, then lay the knife down and do the balance of the skinning with the hands—thrusting the hand around the shoulders, then upwards. This will strip the carcass with not a particle of meat or tallow on the hide. Let the carcass hang out over night to cool.

If more skill and care were exercised in handling mutton it would be better relished and more largely consumed on the farm to the exclusion of so much heavy, salty hog meat and rancid bacon.

Mr. A. S. Smith, an active farmer of Ralls county, and prominent member of the Grange, read the following paper on Farm Homes:

FARM HOMES.

BY A. S. SMITH, ESQ.

Mr. President, Gentlemen of the Board and Fellow Citizens:

I have been requested to contribute something to this Institute,

upon a theme that in its nature and application to the economy of farm life, comprehends the fullness of all effort. The subject is that of "Farm Homes." It is a topic that I approach with much diffidence, because one that has been presented by predecessors so much better qualified, and who have elaborated its attractive and important character so much more fully than I can hope to. The preamble of a beautiful work starts out with the sentence, as an opening proposition, that "Human happiness is the acme of earthly ambition." We might search the English language over and over in vain for a more concise and terse expression of the sum and substance of the great life struggle. Philosphers have consumed the midnight oil, and men in every station have pondered unavailingly upon the great life problem, and with but one conclusion: that whatever line of human effort, from the cradle to the grave, it is but one unbroken struggle to a more beatific condition. No poem has been written that expresses so faithfully this untiring chase as that by J. G. Holland, entitled "The Wings," and I commend it to all readers. But it must be clear to those who reflect even briefly upon the matter, that if all of our life action is devoted to securing happiness, by far the largest share of it must be realized in our home life.

Temperament will always be the prime factors in individual enjoyment, but whatever the employment, the highest type of pleasure can only be obtained in that domestic relationship which cultivates the strongest and most binding attachments, establishes a perfect community of interests, and marks a family segregation from the world at large.

Again, whatever the employment of human mind and hand in after life, the true foundation of character must be laid in the home circle. Then it follows that the circumstances of life and society demanding our first consideration is home. Like all other forms of advancement, our homes of to-day are an illustration of that which ages and ages ago is said to have had its origin in a barbaric condition. The respect for what is now the marital relation, was engendered by the respect for prowess and conquest. This doubtless gradually grew into a sacred obligation as the advantages of such a condition over that of indiscriminate socialism became apparent, until we have our model home of to-day with its holy ties and loving attachments.

The title of this will naturally imply that some difference exists between farm homes and city homes. Doubtless the only marked difference between the two is that the farm home is crowded with more hours of actual toil and less of recreative leisure. This is, in part, a natural condition, owing to an enforced isolation of the farmer from

his fellows in following his daily round of duties, and a lack of those entertainments and pleasant pastimes necessarily cultivated in cities. This difference in social circumstance, embodies the attraction held in city life for the farmer boy, and will in seven cases out of ten, explain the reason why so many young men are drawn from farm life to the city. Now, no actual reason exists why a life in the city, or a city home, should possess any advantage over a farm life or a farm home. My audience will please pardon the implied comparison, but it is necessary to have contrasts in this world, and here is where the contrast exists. Perhaps if I were called upon to point out the complete and triumphant remedy for this difference, I could best do so by indicating the address read by Prof. Sanborn to the State Grange at Sedalia, and accompany it with the single word—culture.

But there are gradations or degrees of culture, and to the most unsophisticated, the word will imply a mental curriculum and a certain associative status. In other words, we cannot assert a fact or state of being without predicating a process to reach it. It is the process that I propose to refer to. Aside from the regular course of study as prescribed in our various schools, there are only two other methods of improving oneself in any character or degree of culture. They are, by reading and by the friction of mental contact in social life. The examples of all notable ambition and aspiration, are, in their outcome, if not in their origin, emulative. Indeed, if you rob life of that strongest of all incentives—competition or rivalry—you at once place a period to advancement.

How, then, shall the farmer cultivate and keep alive those faculties that shall contribute to a well-ordered and happy home? I reply, first by organization and association with his fellow farmers; for, as previously stated, it is only by this means that he can become imbued with a proper sense of the necessities and requirements of life. And now, I trust, having an audience composed mainly of farmers, they will pardon me if I say that the form of organization that comprehends the widest reach of culture, and embraces everything essential to the progress of the farmer, in brief, that inculcates every lesson of home requirement, social, moral and mental necessity, is the Grange. Upon a cursory glance, it may be asserted that the loving ties of filiation and consanguinity may not be heightened or strengthened by any influences outside of home association, but it is not true. The Grange teaches the beautifying and adornment of home, the elevation of the home sentiment and its associations. This, with the consequent knowledge of our inter-dependence, removes selfishness and that peculiar clannishness generated by the persistent isolation of families.

In this respect, the days of feudalism furnish the strongest type of family sufficiency unto itself. It was the fierce clannishness that would maintain family supremacy at the expense of general good.

Doubtless we all have our ideal of home, and while we may labor constantly to secure such a one, it is yet something difficult to define in words. Certain are we that it is something more than

> "Merely four square walls,
> With pictures hung and gilded,"

But a place where all the better qualities of the soul should find expression. Its pictures ar hung in the heart and treasured in the storehouse of the memory. Howard Payne immortalized himself in a beautiful panegyric to it, that has been sung all around the world. Surely every farmer should endeavor to surround himself with all reasonable accessories and auxiliaries to contented and happy living, because none have a higher title to such a life, and none are more plenteously supplied with the bounteous provisions of nature that contribute to life's enjoyment. Not only may he possess and enjoy those things that minister to the creature comfort, but all of the higher qualities of the mind may be cultivated with far more satisfaction than in any other position in life. None are brought in such proximity to that mysterious power which

> "Breathes on the wind and whispers in the breeze,
> Glows in the stars and blossoms in the trees,
> Lives through all life, extends through all extent,
> Spreads undivided, operates unspent."

It would, perhaps, be tiresome to you, to listen to a detailed statement of what I might consider a model home, so a merely general reference in this article must suffice. Then, I will say that aside from those convenient appliances that contribute to our material comfort, there are other vital needs to the well-being of home. There should be hours of recreation, study and amusement. Books should form a large part of the home supplies. Books are an endless source of thought food. We sometimes lose an excellent thought or idea presented by some one with whom we converse, but with books, it is rare if we read intelligently. But all of these matters are impressed and cultivated by the association previously referred to. Without them, we become automatons in the performance of a daily routine with nothing to relieve monotony. In the formation and maintenance of the home, all must be contributive, and who can assist so largely as woman?

No place bears so unmistakably the stamp of woman's individuality, and none will carry the impress longer than those beneath her influence. Barrett says:

"To woman, whose best books are human hearts,
Wise Heaven, a genius less profound imparts;
His awful—hers is lovely, his should tell
How thunderbolts and hers how roses fell;
Her rapid mind decides while his debates,
She feels a truth that he but calculates;
He provident, averts approaching ill,
She snatches present good with ready skill.
That active perseverance his which gains,
And hers, that passive patience which sustains"

It is in the home circle that she sheds her brightest and happiest influence, and where that influence in after life becomes a monument to her memory. Strive to make home a congenial place, thereby demonstrating that life is what we make it. We do not build for the present alone, but for the future. The boys will then learn that it is not necessary to go away from the farm to obtain enjoyment, but that everything that nature, either animate or inanimate, can supply, is to be found upon the farm.

MEETING AT KIRKSVILLE.

The Board met at Kirksville, Adair county, Wednesday, December 21st, 1887. The storm was still raging and the roads were drifted full of snow, making it impossible for farmers at a distance to attend.

The morning session was opened by Secretary Sanborn, who gave a review of the experiments of the Agricultural College farm.

At the conclusion of the Secretary's remarks a short time was devoted to a discussion of the talk.

Mr. Brashear: Do you favor shallow tillage, and by what machine?

Prof. Sanborn: I favor shallow tillage and have used several machines, but know of none that may be considered as a type. I use the

Acme harrow but it is not variable in width. The Ross hoe is no longer in the market. I have known others, but they were in use before the present demand—owing to the growing sentiment in favor of shallow tillage—and are not in our market.

Question: Does clover bear seeds on its roots? I have heard it so stated, but could not credit the statement.

Prof. Sanborn: These nodular protuberances resembling seed found on the roots of clover are at present the subject of much controversy among scientists, who are manifesting great interest in them. Scientists assume that these knots are a normal growth and ascribe to them the great power of clover to gather its large supply of nitrogen from natural resourses.

Ques: How would you cultivate the soil after a heavy rain when it runs together quite deep as it does here very often?

Prof. Sanborn: Shallow; if you attempt to go deep you will cut the roots savagely, for after corn is six inches high these roots will reach across the rows.

Ques: How shall I stack my corn fodder as you say yours is?

Prof. Sanborn: At the college farm our fodder was shocked, dried in a week and stacked at once. We are now feeding it out—a green, nice food. Your fodder is now woody from overdrying and unpalatable from loss of its aroma, leached of its soluble matters by rains. You are too late in saving your fodder to secure a good quality.

Judge Miller explained that in the East an alternate layer of straw and fodder was used in stacking, the dry straw absorbing the moisture from the partly dried stalks.

A recess for dinner was then taken.

AFTERNOON SESSION.

The first speaker introduced was Mr. Levi Chubbuck, of St. Louis, who read a paper on the "Water Supply of the Farm," which will appear in another part of this report.

Mr. Brashear: Is it not altogether impracticable to secure water from a roof, especially during a dry season?

Prof. Sanborn: Our new barn has 8,450 square feet of surface. The average rainfall for a year in this State is thirty-six inches, which gives 25,350 cubic feet of water for a year. Now, by experiment, I

have found that I need less than a cubic foot of water per day. But at a cubic foot per day for one hundred and fifty days this water will be sufficient for 169 head of cattle. We have a spring on a side hill near by from which we can cheaply get our water by using a battering-ram which works continually and without cost. By an engine we expect to elevate the water to a tank above from which it can be led in pipes to any part of the building. This can be done by the windmill, or if a steam engine is used the exhausted steam will take the chill off in winter. The water of our ponds is so cold that cattle will not drink enough to make them eat well and consequently no growth will be secured. This fact I have learned by weighing water.

Judge Miller: I think nature has given us a good hint on this question. Our springs that cattle like best are at a temperature of of about 50 degrees F.

Mr. Patterson: What are the sources of contamination of water? I supposed it was mostly surface water?

Mr. Chubbuck: If the water filters into wells from mineral soils the water will not be contaminated as a rule unless a contaminating cause is near by. From organic matter near by it is liable to gather impurities that will affect its wholesomeness.

Mr. Patterson: Will not a deep well be better than one of the same capacity of any other shape on account of the cost of covering?

Mr. Chubbuck: I think the cost or labor involved in elevating the water to the surface would overbalance any advantage or gain in cost of covering the well.

Prof. Taft followed with his paper on "Insects Injurious to Vegetation."

Ques: Is the apple gouger common in this State?

Prof. Taft: Yes, in some parts, especially in the northwestern section of the State.

Judge Miller: The codlin moth gets blame for much of the injury done by this insect.

Ques: Does not the curculio put its egg in the top of the wound?

Prof. Taft: The crescent shaped cut made by the adult is around the egg. The insect first punctures the fruit and deposits its egg, and makes the crescent shaped cut around the egg afterward.

Ques: Will not the poison you recommend burn the leaves?

Prof. Taft: In the proportions I mentioned it will not. A solution of one pound of poison to fifty gallons of water will not hurt the leaves if it is kept stirred when being applied, so as to keep the poison from settling to the bottom of the vessel, which would make the last of the liquid much stronger than it should be.

Judge Miller made a talk on gardening, a synopsis of which will be found in the following:

The common garden, as we usually see it, is a place for a few potatoes, a little corn, some peas and beans and a small patch of cabbage. This is often so neglected that weeds have full sway, making the crop of vegetables less than it would have been under better care.

This is only half living, and the person who has even the latter is neglecting a duty that nature has imposed upon him. I will now describe one as it should be:

For an ordinary family, one-fourth of an acre, well cultivated, will furnish sufficient vegetables for home use. In laying out a new garden the first consideration should be an asparagus bed and one of rhubarb. These in a few years will richly reward the planter with the earliest vegetables obtainable. Lettuce and early cabbage, peas, beans, radishes, squashes, a few rows of early sweet corn should follow in their regular order. Parsnips and celery should not be forgotten.

In the way of fruit, strawberries, raspberries, currants, gooseberries and blackberries come in succession and add so much to the pleasure of living, besides saving considerable expense of living. There is no comparison between such a garden as this, and the one ordinarily seen on a farm. Yet it is no more than every land owner's duty to provide such a garden for his family.

The boys raised under such influences will have less desire for tobacco and whisky than those brought up under such influences as ordinarily surround a farm home.

In addition to the vegetables and fruits, there will be found room for a few beds of flowers—such as crocus, tulips, hyacinths, roses, annual flowers, etc. Shrubbery on the lawn should not be neglected, for these add much to the cheerfulness and beauty of a home. These will go far toward keeping the girls and boys at home, as they will become accustomed to these luxuries and beauties and will be loth to leave them for uncertain pleasures.

While my farm is nothing to brag about, I can truthfully say there is not a day in the year that we do not have fruit in the house. When a man tells me he cannot afford to take an agricultural paper; that he cannot find time to plant all these things in the garden; that he has not the money to buy the plants, I find on investigation that he spends more money for beer, whisky and tobacco in a single year than would be required to purchase all the plants needed. That he spends more time loafing in the stores and saloons of his neighboring village than

would be needed to plant and cultivate his garden as it should be done.

The very loneliness of a place on which there are no trees, flowers or fruit is sufficient to convince any one that it is really not home and not a suitable place for an intelligent man and family. A good, thrifty vegetable garden is a pleasure, a luxury and an economical investment, and will pay enormous dividends for the labor and capital judiciously employed thereon.

Mr. Patterson. The reason, I believe, that we have such poor gardens is that they require so much work or are supposed to.

Mr. Brashear: I found in my practice last season that by planting my rows eighteen inches apart I could use a horse to good advantage and get along nicely.

Mr. Patterson: How shall we get rid of the cabbage fly.

Judge Miller: By going through the gardens with a switch hitting and brushing about for the butterfly. This removes the cause.

Prof. Taft: To kill the cabbage worm, I find slug shot very effective, but it is costly. As a substitute I use one part of London purple or Paris green to one thousand parts of ashes before the cabbage forms a head. After this I use pyrethrum.

Prof. Sanborn followed with a talk on grasses, which was in part similar to the article on the same subject at the opening of this report.

Mr. Brashear: Would you begin cutting grass a little too early in order to close when the hay was in the right condition to harvest, or would you begin when the grass is right and close when it is overripe?

Prof. Sanborn: Inasmuch as the seed, the richest part of the hay, shatters off if overripe, and inasmuch as the grass will grow less palatable if allowed to stand after the period mentioned, I should prefer to begin too early. But if rotation farming is followed, and clover is grown alone, especially if meadow fescue is grown by itself, ripening before timothy, and timothy is grown, no such necessity exists.

Ques. Is gypsum good for grass?

Prof. Sanborn: Yes; for clover, and it is often good for other places on the farm, but these can only be determined by a trial.

Judge Miller: I knew of a man who grew clover with his wheat for fifteen years. It was sown in the spring and plowed in for the next crop. The last crop of the fifteen years was the best. Does this not agree with your views?

Prof. Sanborn: It in part touches a principle laid down, but I do not dare to draw general conclusions from a single result, obtained perhaps on a peculiar soil for wheat and not unlikely ending in a favorable year for wheat.

Ques. I have a field laid down to grass, but the grass has been killed by drouth. What shall I do?

Prof. Sanborn: Sow again in the spring when the frost will let the seeds into the ground.

Ques. Will seeds that have their hull taken off by threshing make as good growth?

Prof. Sanborn: Whenever a seed has its external coat ruptured or broken, it is liable to absorb moisture and be injured before planting.

Ques. Would you apply manure on the surface?

Prof. Sanborn: No; I have become satisfied that our only way to get the manure into the soil is with fresh seed and fresh sod. By this means we may hope for large yields, otherwise we may expect small or moderate crops.

FARMERS' INSTITUTE AT CORA.

A Farmers' Institute meeting was held at Cora, Sullivan county, Mo., on Thursday, December 22, 1887.

The severe storm had not subsided. The public highways were rendered almost impassable by snow drifts. The Board was delayed in its overland trip from Milan by the impassible condition of the roads, and not did reach Cora in time for a morning session.

AFTERNOON SESSION

Was opened by Prof. Sanborn, who addressed the young men present on the relation of science to agriculture, its opening for intelligent men and its certain aid to profitable farming. He urged them to give the subject their most careful study, assuring them that they would find it worthy of their highest ambition and the application of the broadest intelligence. Science is yet to transform, continued the speaker, the character of farming and farm life, and make it a very desirable, and even fascinating calling.

He pointed out the desirable changes from the present methods of farming, and closed with a brief discussion of wheat growing. He advised them to follow clover with wheat in a regular rotation; that manure be plowed under on rolling land to prevent the soluble portion from being washed away; that ground for wheat be plowed seven inches or deeper than is customary, and done when neither too wet nor too dry, as the kaolin or sticky substance in clays or clay loams makes it sticky in one case and cloddy in the other; that the tillage be thorough, rendering the soil fine; that the seed be carefully selected from plants of the kind desired on the same principles that obtain in the selection of animals. This selected seed may be grown on special plats for the next year's seeding, selection being always kept up. He believed that the proper time to harvest was when the grain would crush dry.

Ques. How long would you grow grass on the same ground?

Prof. Sanborn: I prefer to get fresh roots or fresh plants and fresh soil by frequently plowing and seeding the ground. I give it only two years. Three to five, I believe, is enough.

Ques. How would you apply manure?

Prof. Sanborn: If thoroughly worked into the surface, I get more pounds of corn and less of fodder than when plowed under. But if applied in the fall on rolling land, I would plow it under.

Ques. How many bushels of wheat would you sow per acre?

Prof. Sanborn: Many trials in various States show the best average results from near two bushels per acre.

Judge Miller followed with a talk on Small Fruits, which was in substance, as follows:

At a recent meeting the question was asked: How many good orchards existed in the vicinity? The answer was, but few, and in the best not over three-fourths of the trees originally planted were now standing.

How many of you have good strawberry beds? Out of the thirty or forty farmers present, only four answered and none had a good bed.

Now, continued the speaker, this is all wrong, and should we succeed at these meetings in making every farmer present appreciate his situation and possibilities, much good will be done. For instance, note what great improvements have been made in the strawberry—trace it along from the small wild fruit scattered over the fields a few years ago through all its various stages to the enormous sized berries that are grown to-day with comparative ease. Young men, instead of wishing for some *refined*, so called, profession, such as the law, medicine or the mercantile world affords, be content with the farm; plant fruits and ornamental trees, and make home a pleasant place in which to dwell. Be an independent man, such as no other profession affords, surrounded by all the beauties of nature which you can so easily secure. Subscribe for and read some good agricultural paper, keep abreast with the times by habitual study, thrift and economy, and you will appreciate that it is not only a pleasure to have your home surrounded by all the comforts and adornments, but that it is your imperative duty!

Prof. Taft was the next speaker, and gave a lecture on Insects Injurious to Vegetation. This lecture covers substantially the same points as will be found in an article on pages in this report.

At the conclusion of the address, the meeting was adjourned.

MEETING AT TRENTON.

An Institute meeting was held at Trenton, Grundy county, Mo., December 23, 1887. This meeting was held under more propitious circumstances than those of the preceding days. The storm had abated, and the snow drifts were well trodden down. As a consequence, the attendance was larger than that of former meetings, and was made up of a fine class of men who gave close attention and took an active part in the discussion.

This meeting was not a large one, however, there being only about fifty farmers present. It may be well to note in this connection, that in large towns much the smallest meetings are held.

Secretary Sanborn opened the meeting by speaking of the causes of soil depletion; of the necessity for a repleting system of farming if we are to maintain the ascendancy of American agriculture—an agriculture that must afford the means to sustain a higher type of man and more elevating home influences on the farm than are maintained in other countries.

To maintain this more costly home and public life will require the application of more brains to our farming than is now in use in most cases. In other words, the development of modern science must be applied to our agriculture in order that we may successfully compete with the brawn of other countries.

AFTERNOON SESSION.

The afternoon session was opened by Mr. Chas. Patterson, a prominent fruit grower from Kirksville, Adair county, Mo., who delivered the following address on "Faith in Profitable Apple Growing in the West:"

FAITH IN PROFITABLE APPLE GROWING IN THE WEST.

BY CHAS. PATTERSON, ESQ.

It seems that your wide awake officers have happened to hear of my planting 12,000 apple trees last spring on a solid 80 acres of ground, and therefore kindly invited me to give you a paper on this subject. The invitation might also be construed as a demand to give a reason for the faith that is in me, or to show, if I can, that I am not a visionary enthusiast or losing my mental equilibrium. Of course I have no serious apprehension that you will fail to show and feel all the respect that is due to anything I may say, but if your orchards do not speak for you and against me louder than words I will give you credit for

doing far better than my neighbors at home, with scarcely any exceptions. I have had to take most of my lessons from others by contraries, by warnings how not to do it, and I would go 100 miles afoot if necessary to see an orchard 20 or 15 years old that I would call even approximately well taken care of.

Some ten or twelve years ago I went into a neighbor's orchard for some scions that I could not well procure elsewhere. There were six trees about 15 years old but I could not find a single scion of last year's growth even two inches long. In fact, they seemed to have made scarcely any growth at all, and as they had never been pruned, as far as could then be judged, there was not even a water sprout. The ground was closely set in grass which had been mowed or pastured for years as had seemed easiest or most remunerative. That orchard, about 10 acres, had been written up and talked about as proving the excellent wisdom of planting orchards for profit in our county. It was scarcely known to have failed of a remunerative crop, and had actually paid for itself exceedingly well. But I quietly made up my mind that it could not continue to do so many more years, and sure enough it has never borne a single crop since. I had not observed this want of growth in orchards before as I have since. Now I can distinguish it from the car window at a distance of several hundred feet, summer or winter. And I very seldom see an orchard of the same age that is in much better condition. Our soil makes a peculiarly close sod and finer hay than western Missouri or Illinois, as far as I have seen, and therefore our trees will show this condition several years sooner, but it is only a question of time in almost any place, and wherever we find this want of growth it is safe to predict that we will find very occasional crops and mostly small fruit in the exceptionally favorable seasons, and also a number of dead and dying trees.

What right have we to expect anything else? Do we find large, plump raspberries and blackberries on small stunted canes struggling in sod for a puny existence? No! The berries will be in proportion to previous year's growth of canes, as well as the season for growing and ripening of berries. Do we expect to gather large corn whether we push a large growth of young stalks or not, if the season happens to be right? Not as a general thing. We have occasional seasons when most any management gives a fair crop, but they are as far between as our good apple crops. Do you think there is a wide difference in an annual like corn that has to grow its whole supply of roots to suck up plant food for leaves and grain every year, and an old tree that has already such a system of roots to draw its supply from deep down and near the surface? My observation and reasoning indicate that they

are exactly parallel, that the tree extends a system of new roots every year as well as corn does, and that when root growth is stunted and obstructed it ceases to grow at the top and can no more bear fruit than the stunted corn stalk can bear a full sized ear of corn. We have all made a mistake in overlooking this parallel. It has become almost a stereotyped direction in our reports and instructions to sow the orchard to grass when it begins to bear, or when we wish to hasten that period, and this hastening process is to-day regarded as a triumph and vindication of a slovenly and delusive practice. The Jews gained a similar victory for orthodoxy on Mount Calvary and have not yet admitted their mistake although they never could avert or escape from the consequences. In view of such inrooted and mistaken obstinacy, permit me to repeat and lay it down as an axiom, that when an apple tree cannot make a free extension of root growth it also fails to make a clean, healthy growth in the top and the fruit will be exactly in proportion in development and bulk though the number of apples and seeds may be multiplied. When the tree suffers any injury, such as taking off a ring of bark, driving a number of nails in the body, boring holes, girdling borers, twisting wire around the body or limbs, it immediately directs its forces to repairing the injury and also to reproduce itself by seeds, as if conscious that the end if its destiny is in danger of early defeat. Grass sod long continued, tramping by animals, or anything that obstructs the free passage of water and its solutions of plant food from the surface soil to the roots, has the same effect in shortening its growth and producing fruit prematurely as the direct mechanical injuries referred to.

Neither can the apple tree find all the nourishment it needs down below the range of grass roots, as maple, ash, etc., seem to do. This difference can be regarded as an infinitely wise provision, rather than a defect. It conveys the promise of reward for dilligence, and mental and physical activity, where sloth and indolent avarice will be "left" to bitter but well-deserved disappointment. While we expect but mere germs for reproduction in these forest trees, and their highest usefulness to us is found in their dead carcasses, with only incidental shade and beauty when in their prime, we may confidently pronounce the fruit of the apple tree, and its numerous auxilliaries, the lever that elevates us on the physical plane above the primitive and gross "hog-and-hominy-age," with its degenerate cravings for alcoholic stimulants. Is the difference not well worth some extra work? Could we reasonably expect regular crops of fruit with the same labor as would produce a grove of forest trees? Is it visionary to expect results in proportion to our efforts in this direction? Is it visionary to plant a large

orchard on the plan of this departure, when I see plain decay and destruction all around me with the old methods? Is it safe to estimate that this departure will be twenty years on the road to general acceptance and practice, and will witness still more and sorer disappointments of the few who now have promising young orchars, and may never reach the average farmer?

The apple tree must and will have at least a share of dissolved plant food from the surface soil. This a dense mass of grass roots, or a tramped and naked surface, will prevent from reaching the apple roots originally grown for surface feeders. Put the plow into your old orchard sod, as shallow as you can split it, and you will cut a large mass of apple roots. Where do they come from and what do they come for? There was not one of them when you quit cultivating, whether at four, eight or twelve year age of trees. At least I have never found one in my ten-year-old orchard. They are sprouts from horizontal roots, and perhaps extensions from former terminals that seem to be sent up to get a share of the nourishment referred to before the grass roots shall have appropriated all. Said a distinguished doctor to me, as we passed a stately old apple tree full of very small fruit and making no wood growth, as plainly indicated by the color of the leaves: "What is the matter with that tree? What makes the fruit always so small?" I answered: "Starvation." "Tut, tut, man," said he, "what do you mean? Do you see that grass and clover, at least two tons to the acre; do you call that land poor?" I said: "No, the land is rich, but the tree cannot eat green grass, and the grass roots are too numerous for the tree to get the nourishment it requires, and is therefore starving almost as effectually as your horse would be if you were to tie up his head and turn him loose in that luxuriant grass."

But some of you will say, we have lost our trees largely by hard winters, and the remnants are so badly damaged that they might as well be dead. If we had cultivated as you advocate, they would have been still more liable to get killed, even in moderate winters. I approach that question with far more diffidence in this latitude than I would at home, and will not venture to assert that your orchards in the extreme North could have been saved by my method. But I will say that cultivation in the early part of the season does not make them more tender. Late growth, unmatured sap suddenly expanded by severe freezing, as occurred the 18th of December, 1884, I think is what did nearly all the damage, and might have been ameliorated by early cultivation, followed by buckwheat or rye in the fall. Though I know but little personally of the previous condition of your lamented lost

and crippled orchards, I will venture a doubt of their thrifty growing and bearing condition at the time, if the winters had been as notable for mildness as they were for severity. I think it far more likely that they were in that semi-dying or despairing condition so conspicuous in all my observations, and if so, you will surely not contend that the starving process I have tried to describe was a success in preserving your trees. On the contrary, you will concede that the tree which has been barely able to keep alive on its scanty rations for years must be more susceptible to abnormal hardships, just as a calf or a man can better resist vermin, disease or cold when well fed, and that possibly you hastened their early departure by omitting what you might have done for them. I heard of an orchard last winter, less than sixty miles north of me, which the owner had despairingly grubbed out at sixteen years old, because the trees were nearly all dead or dying. That man honestly believes that nothing but the arctic winters killed his orchard, while I just as confidently believe that he ignorantly starved it to death, and at the worst he is but little worse off than many others, whose orchards insist on a prolonged agony.

Young trees, especially in the nursery, are far more subject to winter hurt than old orchard trees. I well remember reading and hearing it spoken of at Kansas City, when the Mississippi Valley Horticultural Society met there, that young orchards and nurseries had been extensively damaged by bark bursting in Arkansas and, I think, Texas, a few years before. I have not since heard that they abandoned orchard planting or waited for iron-clads to be imported and tested or grown from seed. I do not mean this allusion as any slur on these efforts, but I cannot afford to wait for such far-off demonstrations. And besides, though I confidently hope for final success in finding trees that will go to rest at a proper season and not be awakened by delusive sunshine and showers in the fall, yet I have no hope whatever that any variety of apple will ever be found that can thrive in grass sod indefinitely. We will always have to see to it that our trees make a normal, healthy growth, not excessive, especially in the fall, but not less than six to twelve inches on the main termals.

This is the main base for my hopes of success in orcharding. I am sorry and chagrined to think that I have never seen an old orchard continuously managed as I propose, and well nigh despair of finding any this side of Michigan or New York, where I think they must be found, at least here and there. I have, however, some reliable accounts of orchards continually increasing at the age ours usually begin to decline. What I now call my old orchard of thirty acres is only ten years old.

A neighbor planted forty acres at the same time, which has only been cultivated in part, thought about like the average. He had some fruit several years before I had any. But my first crop more than doubled all he had had then, and each crop since has more than doubled his. The stems and tops of my trees are one-third larger than his by measurement, although I had trimmed them up five to six feet high, but for which they would doubtless have been some larger. I have lost more trees by winter hurt than he has, especially where I cultivated rather late in the fall of 1884, but counting in all other causes, which continually occur, I have 80 per cent. of the first planting, yet in bearing condition, which does not at all discourage me.

As I have called cultivation the base on which my hope of success rests, I will call prunning one of the main stays, and will call your attention to it, because it is about as universally neglected, and requires the next most labor. A man who will guard well these two points, needs not often be reminded of rodents, insects, etc. etc.

Nature is always profuse and lavish in her provisions for increase and against contingencies. Every bud is capable of making a branch, and, as there is plenty of room next spring, a larger number start out than will be needed in the future. Many of this surplus, nature will soon try to suppress by overshadowing and withholding sap, but they obstinately refuse to surrender, and insist on dividing the common stock of nutriment, and compelling their rivals to await their company until they are entirely too crowded, and even generous cultivation and manuring can hardly furnish enough nutriment to go around in liberal measure. We are put here to dress and to keep them, or to assist nature in her efforts to suppress this surplus, and not to wait for her to do it.

Take a tree that is properly thinned out in planting, and has made one year's good growth in the orchard. The first thing I would have in view, would be to get a sufficiently high stem. Many of our folks are disgusted with low headed trees. As soon as I could obtain a desirable stem, and corresponding top, I would thin out all branches that a mental picture of future shape would show to be superfluous. Never cut off the leader, unless it threatens to grow out of balance, and then try to have another to take its place. Never tolerate a fork, but cut out one prong at first sight. Follow out every branch and thin out the sub-branches, as indicated for the leader, and it will never become such an immensely bushy mass as we generally see, and you will seldom need to make any large wounds or severe drain on the trees, or check to its growth.

Question: How do you exterminate the borer?

Mr. Barnes: I have tried the various washes recommended but to no effect.

Judge Miller: The best way is to keep the borer out. To do this, I wrap the body of the tree with a double thickness of newspaper up to the limbs and throw a mound of earth around the base of the tree.

Question. Why not use tarred paper?

Judge Miller: It injures the trees.

Mr. Patterson: I am asked how to fix up an old orchard? If necessary, get a pair of hand shears made for the purpose and trim up the small branches. If any old limbs have to be cut out, do so moderately and paint the wound. They may need another application of paint later on; if so, paint them. Cultivate the ground between the trees well and you will get a crop that pays.

Question. Do you approve of pasturing an orchard with pigs?

Mr. Patterson: No; although pigs may till the soil to some extent by rooting.

Question. How long may we expect to have orchards live under average conditions?

Mr. Patterson: In our county, Adair, from 12 to 16 years.

Mr. Morrow: Is there any advantage in planting seed to get a vigorous tree?

Mr. Patterson: Whether there is or is not it is impracticable to do so. Much controversy has arisen over the question as to what size or length of root is best for grafting. In other words whether it is best to graft on the whole root or a section of the root, and if a section, what length is best, etc. I am in favor of a short section of a small root.

Ques. What is your objection to allowing trees to branch low?

Mr. Patterson: They cannot be cultivated so well as when they are made to branch higher.

Auditor: I grew an orchard with low limbs and the result has not been satisfactory.

Mr. Patterson: I set in rows 29 feet apart and 34 feet between the trees.

Judge Miller followed with a talk on fruit growing and on opening the subject for discussion the following questions were asked:

Mr. Hubbell: What do you regard as the best raspberry for Missouri?

Judge Miller: Of the blackcap variety, the Centennial, Gregg and Mammoth cluster. Of the red variety, the Turner, Schaffers Colossal, and Cuthbert. Of the yellow, Caroline and Orange Queen.

Ques. How do you like the Souhegan?

Judge Miller: It is too sour, and the Marlborough is worth less in my judgment.

Mr. Patterson: The Souhegan is popular around Quincy.

Ques. Do blackberries fare well in our climate?

Judge Miller: I find the Snyder the best for my place. The Western Triumph does well.

Ques. How do you like the dewberry?

Judge Miller: It requires more care and intelligence than the blackberry. It should be trained on a pole. In the spring take the tips away.

Ques. Is not the Snyder a late berry?

Judge Miller: No; it is an early variety.

Ques. How do you propagate the Snyder?

Judge Miller: Take up the roots in the fall and cut them into small pieces. Put the pieces in sand and store away in your cellar for the winter. In the spring plant them like you would potatoes.

Ques. Did you try the early Harvest?

Judge Miller: No; I had no faith in it and have not heard any good word for it yet.

Prof. Taft: I have some and last season I counted one thousand berries on one cane. It ripened and was out of the way before the severe drouth set in.

Mr. Hubbell: I got the Early Harvest two years ago, and the fruit ripens in June. I believe it is the earliest blackberry we have in the State.

Prof. Taft: From my experience with raspberries, I would recommend the Hansell, Turner, Schaffers Collosal, Souhegan, Gregg and Hopkins.

Judge Miller, in answer to a question concerning the Marianna plum said: I find it a poor plum, and only use it for stocks as it grows as freely as a willow from cuttings.

Ques. What do you know of the LaConte pear?

Judge Miller: I regard the pear sent me as a good grower, and promising well.

Prof. L. R. Taft followed with a lecture on Insects Injurious to Vegetation. At the conclusion of this lecture a short time was devoted to a discussion.

Ques. Is it an insect that produces blight?

Prof. Taft: No; sun scald or a warm fall causing a weak, rank growth, and other causes, give rise to blight. This blight may be avoided by a sound and regular growth of the tree.

Ques. Do borers attack one variety of apple trees more than another?

Prof. Taft: That depends almost wholly on the character of the bark. A rough bark invites them, while a smooth bark will repel their attack.

Ques. Do you like the Winesap?

Prof. Taft: Fairly, but I like the Jonathan better, and feel assured that it will be more popular than the Ben Davis as an early winter apple within two or three years.

Ques. How do you like the Baldwin?

Prof. Taft: It is a very good early winter or late fall apple, but it does not succeed in all localities. It is very popular in the East.

Ques. When would you gather apples?

Prof. Taft: For long keeping they should be picked as early as the stem will easily separate from the limb.

Ques. When would you set trees?

Prof. Taft: As early in the spring as the soil will work well. I never like to set trees in a wet soil. If the springs are usually so wet as to force you into late planting, I should then advise planting in the fall, provided water does not stand on the surface in the winter.

Ques. Do you favor setting a tree leaning to the southwest?

Prof. Taft: They may be leaned slightly, but I prefer to plant them erect with the longest roots on the southwest side, to assist in holding the tree in place. It is a good plan to place a barrel stave on the southwest side to prevent the sun scald.

The meeting then adjourned.

INSTITUTE MEETING AT GALLATIN.

An Institute meeting was held at Gallatin, Daviess county, Mo., December 24, 1887.

Secretary Sanborn opened the meeting with a talk on the needs of Missouri agriculture. The questions and answers cannot be reported as the speaker was kept busy answering them.

Prof. Taft followed with his lecture on Insects Injurious to Vegetation, which will be found elsewhere in this report.

Question. What crop would you grow with an orchard?

Prof. Taft: For the first few years after setting, I would grow some crop that requires tillage in order to till the soil for the benefit of the trees. Corn answers the purpose quite well, but no hills should be within six or eight feet of the tree.

Ques. At what season would you set trees?

Prof. Taft: I should prefer to have them set in the fall rather than late in the spring or in wet ground in early spring. On well drained soil, fall planting is most successful, especially if a dry summer follows.

Judge Miller then talked on Small Fruits.

He said that in an audience of thirty farmers which he had recently addressed, there were only five that had ever had all the strawberries they could eat. This he took as a text to impress upon the minds of the present audience the importance of cultivating small fruits.

In answer to a question relative to the value of small fruits to a farmer, he stated that he had supported from two acres of fruit a family of seven.

Ques. Where will the farmer find a market for his small fruit?

Judge Miller: If any one will grow good strawberries, I will guarantee a market as the supply develops a demand.

Ques. Should the sterile flowering strawberries be planted with perfect flowering kinds?

Judge Miller: Yes; for illustration, the Crescent Seedling and Capt. Jack should be planted side by side.

Ques. What kind of land is best for watermelons?

Judge Miller: A low, sandy bottom land.

Ques. Will not upland do?

Judge Miller: Yes; by the liberal application of manure. Raise the hill and place sufficient straw between the rows to keep down weeds and conserve the moisture.

Ques. How shall we handle the raspberry canes?

Judge Miller: Pinch back the new canes when they are two feet high. Cut out the old canes as soon as the fruit is off.

Ques. How large can you grow them?

Judge Miller: I have grown the Schaffers one inch in diameter.

Ques. How do you support tomato vines?

Judge Miller: Tie up to wire, brush or stakes—anyway to keep them off the ground.

MEETING AT CHARLESTON.

A Farmers' Institute meeting was held at Charleston, Mississippi county, Monday, December 26, 1887.

A misunderstanding on the part of the ticket agent as to the connection of the trains on which the Board had to ride to reach Charleston from their meeting at Gallatin prevented a morning session.

AFTERNOON SESSION.

The meeting was opened by the Secretary, who spoke of the broad changes in our system of farming that are necessary for the continuance of our prosperity. The speaker was without means of making note of the questions and answers that followed.

Prof. L. R. Taft followed with a talk on Insects Injurious to Vegetation.

Ques. How often is it necessary to wash a tree to keep the borer out?

Prof. Taft: Once a year.

Ques. Would you use leached or unleached ashes?

Prof. Taft: Unleached. They contain the potash.

Ques. What quantity would you use?

Prof. Taft: From a peck for a small tree to four or five busels for a large tree.

Ques. How would you apply?

Prof. Taft: Broadcast and for some distance from the trunk of the tree, as the feeding roots are at the end of the roots.

Question: Would you advise growing cow peas in an orchard?

Prof. Taft: Yes.

Question: Would you throw the dirt to the trees in plowing an orchard?

Prof. Taft: No; not as a practice, as a bank is injurious to the tree.

Question: How deep would you plow an orchard?

Prof. Taft: Shallow; close to the tree, so as not to cut the roots.

Question: How would you thin out the fruit of a young tree?

Prof. Taft: By removing the small and imperfect fruit when a quarter grown, leaving only as much as the tree can perfect.

Mr. Chas. W. Murtfeldt, of Kirkwood, St. Louis county, Mo., former secretary of the Board, and a man who takes much interest in agricultural problems, delivered the following address on

THE VEGETABLE GARDEN.

BY CHAS. W. MURTFELDT, ESQ.

Every farmer has the right to partake freely of all the good things the soil produces. Among the essentials of a good table are plenty of well grown and wholesome vegetables. By plenty I wish to be understood as meaning a variety of vegetables in their season. And it is a pity, and "pity it is 'tis true": that while the majority of farmers are fond of a good table and variety of food, most farmers will either leave the growing and cultivating of vegetables to wife or daughter, or will sow or plant a garden after all the field crops have been put in. Every thinking man will see at a glance that under such circumstances it is impossible to have vegetables in their season or in perfection, and just when the appetite craves them. Radishes and lettuce should come before strawberries or peaches.

All vegetables, almost without exception, are best and most palatable when matured by rapid growth, therefore the ground of a garden should not only be rich with well composted fertilizers or plant food, but it should also be in good tilth, viz.: mellow and well pulverized. To furnish these conditions is comparatively easy in a naturally rich, warm and sandy soil; but in a stiff and retentive clayey soil, more manipulation, care and discrimination are necessary, so that it may not be worked when too wet or too dry or too cold.

Sand and wood ashes—leached or unleached—and even coal ashes, will aid the disintegration. A few wagon loads of soil from the woods, if mixed with sand and domestic guano, will make valuable additions and will stimulate quick growth. In the application of unleached wood ashes care must be taken that the ashes do not come

into immediate contact with the seeds, because it will impair or kill the germs. Last year the finer varieties of my peas failed to germinate because I sprinkled with a good coating of ashes—which I presumed were leached—over the seed before covering with soil.

All garden vegetables need frequent cultivation—it can hardly be too frequently or too well done—not only to destroy the weeds, but to keep the soil loose and porous, and to make it warm.

The next thing to take into consideration is the hardiness of some vegetables and the tenderness of others. It will not do, for instance, to plant cucumbers or beans early in the season; but you may—nay, should—plant the following named varieties as early as possible, provided the soil is in good condition, namely: Spinnach, peas, potatoes (Irish), radishes, lettuce, onions, beets, turnips (for spring use), carrots, cabbage, cauliflower, kobl rabi and parsnips. When danger from late frosts is over you may plant cucumbers, melons, squashes, beans, egg plant, okra or gumbo, and sweet potatoes.

On a farm or for market-garden purposes, nearly all the vegetables should be grown in rows as long as possible, so that most of the cultivation can be done by horse power, which is the most expeditious; but the hoe and the rake cannot be neglected without loss.

For a small garden it is best to buy plants of reliable gardeners; it will be cheaper in the end. Early cabbage, cauliflower, egg plant, kohl rabi, sweet potato, and tomato, all of these need replanting, and in nine cases out of ten can be bought cheaper than they can be grown; but where this is impracticable a small cold frame, even if covered only with cheap, unbleached cotton cloth, will raise a great many plants. Tomatoes are very much improved by several transplantings; they can be taken out of the cold frame when quite small, planted in boxes which will hold a dozen or more; again removed into thumb-pots or any available substitute, and lastly into the open ground. Of course they will need protection, either from the sun and also from cold storms during these transplantings.

A cold frame can be made with a few plank or boards of the desirable size placed in the soil edgewise and reaching from four to six inches above the level of the soil; cultivate the subsoil deep, place upon this a thick coating of compost and fine sandy soil well pulverized, and covered with a frame of sash either of glass or cloth, as above hinted. Supply moisture when necessary, and in warm days either raise the sash, or remove it entirely, so that the plants become hardy. It requires constant care to prevent the young plants either from damping off or from burning up or from freezing out. The difference between a hot bed and a cold frame is this: That the hot bed requires bottom

heat (generally generated from horse manure) as well as glass sash covering, and generally more expensive, elaborate and careful preparation and handling, while a cold frame requires no bottom heat, and can be managed by any level-headed boy or girl of twelve or fourteen years of age.

Very many of our garden seeds are small and need only a covering of one-fourth of an inch of soil, while cucumbers, melons, squashes, pumpkins, etc., should be covered at least an inch deep. Beans and peas should be covered by from three to five inches of soil. Carrots, parsnips, turnips, onions and beets are very apt to be sown too thick, and the plants need thinning out. Young beets can be used for "greens," and others can be left where pulled out and thus used for top dressing; continue this process of thinning out until the plants stand at the proper distance apart to yield best results. Cabbage, cauliflower, kohl rabi and plants of this character should be grown from two to three feet apart; tomatoes from four to six feet apart in the rows. I always drill in my peas, taking care to have the dwarf varieties by themselves. Bush beans may also be sown in drills or planted five or six to the hill and one foot apart in the rows, and the rows wide enough apart to admit of easy cultivation and gathering—at least three feet wide.

In order to have them in season there should be at least three or four sowings a few days only apart; so also of bush beans. You may plant the improved Valentine as late as August first, or even later, and have a good table supply until frost. Of peas the following named sorts, if planted on the same day, will mature for the table in regular succession, while in Central and South Missouri all late planted peas (no matter what variety) will be destroyed by mildew.

First and best—Carter's First Crop, Landreths and Philadelphia Extra Early, and Early Kent. Of these there is very little difference in the time of maturing. Next in order are Bliss Wonder, England Imp., Tom Thumb, McLeans Little Gem, Little Blue Peter; and next, Stratagem, Eugenia, Blue Imperial, and Champion of England, and lastly, Black-eyed Marrowfat.

Of bush beans I would recommend Early Six Weeks, Early Mohawk, Black and Golden Wax, Improved Red and White Valentine, and White Marrowfat. Of pole beans, Large White Lima, Early Dutch Case-knife, and Cranberry or Horticultural bean.

Of cabbage: Early York, Early Winningstadt, Marblehead, Drumhead, Flat Dutch and Dwarf Savoy—the last the most delicious of all.

Of radishes: Long Scarlet, White and Red Olive Shaped and Yellow Summer. Of Tomatoes, Perfected, Acme, Trophy, Golden Trophy. The three most delicate and highly appreciated vegetables, viz.: Asparagus, celery and cauliflower, should be treated more *in extenso* and in a separate essay.

Mr. Levi Chubbuck, of Colman's *Rural World* staff, read a paper on "Farm Water Supply."

MEETING AT DEXTER CITY.

An Institute meeting was held at Dexter City, Stoddard county, Missouri, December 27, 1887.

Prof. Sanborn was the first speaker, and gave a talk on grass growing.

Mr. Murtfeldt followed with a talk on grass. He advocated blue grass for pasture. In curing hay, regardless of cost, he continued, the physician's method is the best. I would use hay caps, as under these hay will cure the best. If cutting hay to feed to horses, I would wait until it was nearly ripe. A great deal of the hay that comes into St. Louis was dried up before being cut, and is no better feed than straw.

AFTERNOON SESSION.

Mr. Murtfeldt opened the session with a talk on cattle husbandry.

Mr. Levi Chubbuck followed with an address on the subject of science applied to agriculture.

Prof. Sanborn then spoke on cattle feeding.

EVENING SESSION.

Prof. Taft was the first speaker, and discussed fruit growing.

Other duties prevented the Secretary from making a full report of this meeting. It was one of the best held up to this time, being liberally attended.

MEETING AT POPLAR BLUFF.

An Institute meeting was held at Poplar Bluff, Butler county, Wednesday, December 28, 1887.

The morning session was opened by Secretary Sanborn, who discussed the value of more grass in a higher method of farming.

AFTERNOON SESSION.

Prof. Taft spoke on fruit culture. A brief synopsis will be found in the following: I would not go to either extreme in growing apple trees. A two-year-old tree is safer for farmers than either an older or a younger one. In setting them out the ground should be well prepared and fertilized. A peck of wood ashes and a small quantity of bone, ground fine, scattered on a diameter of two or three feet around the tree will do well as fertilizers. In buying trees look out for traveling tree agents. In this remark, I do not include local agents acting at home. Reliable nursery dealers protect their customers as far as possible, but often their agents sell trees under false names and at varying prices. I have seen them sell trees at from forty cents to one dollar which could be bought at home nurseries for fifteen cents. I would advise every farmer to send in his own order direct to the nursery. In good soil

put them out thirty feet apart. But in very good soil, and under extra care, they are sometimes set fifteen feet apart, and after a few crops have been grown thin out to thirty feet apart for a permanent orchard. Never expose the roots of trees after buying until planting. Trim off all broken roots, as they will then send out new roots quicker than if left on.

The most important point after planting is to secure sufficient moisture around the roots for the first two years. The soil should be cultivated for a few years. This tillage should be shallow, and be repeated several times during the season of active growth. By this means we secure a layer of fine earth on the surface which acts as a mulch and retains the moisture which would otherwise be evaporated. If for any reason cultivation is impracticable, the trees when first set should be thoroughly mulched. Clover may be grown in the orchard, and when ripe cut and packed around the trees. If the crop is removed, the growth of the trees should be kept up with ashes or decomposed manure. I would not advise growing potatoes in an orchard. For in digging them you necessarily cultivate the soil. This is usually late in the season, and after the trees have virtually ceased growing. This cultivation has a tendency to induce late growth of a tree, and winter finds it full of sap, its wood unmatured, and it falls an easy victim to its cold blasts.

In pruning it is best to go over the orchard once or twice a year, taking out such branches as appear to be unnecessary. This can be accomplished with an ordinary pocket knife and a saw will rarely be called into use in the orchard. Should it be necessary to saw off a large limb, it will heal quicker if taken off in June, when growth is most rapid. But a large limb in full leaf if taken off, deprives the tree of so much of its *lung* area, and is deleterious to the health of the tree. To accomplish this and avoid the disadvantages named, cut the branch off before the leaves have put out in the spring, leaving a stump about a foot long, which may be cut off in June without checking the growth.

Ques: What varieties do you recommend?

Prof. Taft: For home use in most parts of the State, Early Harvest, Red June and Red Astracan for summer; Maiden's Blush, Rambo, Fulton and Smiths Cider for fall; Jonathan, Janet, Huntsman, Ben Davis and Small Romanite for winter. Belleflower, Lowell, Winesap, Missouri Pippin, Lawver, Willow Twig, and others, do well in most localities. For shipping purposes Jonathan and Ben Davis are most profitable. There is considerable call for Huntsman and Willow Twig.

Ques: What part of the Russian tree business is a humbug?

Prof. Taft: That part in which the tree agent is concerned is about all humbug. Several of our standard varieties, such as Red Astracan, are of Russian origin. The fruit of most of the new varieties is small and of poor quality, but their hardiness makes them of value in Iowa and other Northern States.

This was followed by Mr. Murtfeldt, who gave a general talk on agriculture.

Mr. Chubbuck then discussed the relation of education to higher farming. He said that Webster's reply to the young lawyer would also apply to the profession of agriculture—for a profession it is.

Our agriculture is pursued on a low level by the average farmer. Between the highest type of farming and the lowest there is a wide difference—wider than prevails in other occupations. In the horse market of St. Louis prices vary from $15 to $200 per head. Very few are growing this better class of horses. Here is a good field of investment. The increased demand for a better class of horses, both draft and pleasure, has opened up a new and important field. It has long been a practice on my father's farm to breed from work mares of the farm, keeping more than are needed for work. It is easy to sell colts for $50 at weaning time. By breeding a portion of the mares in the fall and a portion in the spring we have mares for constant use.

EVENING SESSION.

Prof. Sanborn spoke on the relation of education to farmers.

Mr. Murtfeldt followed with a talk on "Farm Homes."

Mr. Chubbuck gave a talk on "Woman on the Farm." He claimed for her the same conveniences in the household that man had on the farm.

Mr. Crumb, a citizen of Poplar Bluff, offered a few remarks on the subject of "Farm Homes." He said: Our national surveys have been unfortunate in isolating our farm homes. How this may be corrected I do not know, but believe it will be done at some future time. In Germany they have their homes radiating from a common center and social life is strong. In our country we need to do more to make farm homes pleasant and attractive. Education will do much in this direction.

MEETING AT LEBANON.

A meeting of the Board was held at Lebanon, Laclede county, on Thursday and Friday, December 29th and 30th, 1887.

EVENING SESSION.

The Board received an unusually warm reception. A large delegation met it at the depot and the attendance for a night session was large and composed of very intelligent men.

The session was opened by prayer and music.

Secretary Sanborn gave a talk on the relation of the sciences to agriculture, and gave illustrations of the value of the sciences in its application.

Mr. Murtfeldt followed with a short talk on "Farm Homes."

FRIDAY MORNING SESSION.

The morning session of the second day was opened by Mr. D. J. Bissell, of Amoosa, Iowa, who gave a talk on "Shallow Culture of Corn." The following synopsis of his remarks will give an idea of the points covered by the speaker. He said:

Believing that agriculture is the basis of all our national enterprise and prosperity, and that on that sure foundation all industrial institutions and enterprises may stand secure till time shall be no more, and just as agriculture progresses so will our country prosper and progress, physically, morally and intellectually, it is meet that we should seek the best means for the improvement of our agriculture.

While I have no hobby in agriculture and while I see vast improvement in some directions, I also see a retrogression in other directions, and especially is that the case in the culture of the corn crop. It is an

indisputable fact that the yield of corn has decreased very much per acre within the last thirty years. Especially is this the case in the West. The question arises, why is this so? There may be various causes that might have an influence in some degree on the production of such results, but the question is substantially answered by the simple statement: Imperfect or erroneous system of culture. We have here in the West some of the richest and best corn land on the globe, while in the eastern States they have some of the most sterile of the tillable land of the temperate zone, so much so that they would be glad to buy our soil at a dollar per cubic yard (delivered on their farms) for fertilizers, yet they produce better yields of corn. No other reason can be given for such results than this—a better system of culture. The question arises: What system shall be adopted or what changes made? I answer, a system that will preserve the roots entire without even mutilation, and at the same time conserve the moisture in the soil and render the elements of fertility in the soil soluble and in a state or condition to be taken up by the myriads of fibrous roots and conveyed to the main plant, and thus secure a vigorous growth, which result may be obtained in seasons of the greatest droughts. There may be exceptional cases where this system would fail, but they are only exceptions where there is a very light sandy or a loose gravelly soil where there is no capillary action.

What system shall we practice, do you ask? Before answering that question I will say, principles are stubborn and unbending. As unbending as any of the attributes of Jehovah. We cannot bend them to our practice, but we can conform our practice to their requirements. And when we do that we obtain the best possible results for our efforts.

The system that I would practice would be to cultivate very shallow and leave the surface as flat and smooth as possible. And I would keep it as fine and loose as practicable to the depth of one and a half or two inches. Cultivated in that way I never knew a drought so severe as to injure corn, and I have practiced it for many years without a failure. At least long enough to pass the experimental term. I am convinced that where thirty bushels of corn is obtained by the culture with shovel cultivators running deep and cutting the roots that eighty bushels may be obtained with even less expense. What philosophical explanation can be given for such an increased production? First, the roots always go in advance of the stalk. When the stalk first makes its appearance the roots have extended several inches laterally near the surface, and they will keep in advance of the growth of the stalk during its entire growth, drawing and con-

veying to the stalk nutriment and moisture to enable it to produce the ear and perfect the grain. The fine loose dirt at the surface serves as a perfect mulch to prevent undue evaporation of the moisture that is drawn from below by the capillaries in the soil holding in equilibrium the moisture between evaporation above and percolation or gravitation below. Being thus protected the roots will permeate the soil to considerable depth. From six to ten inches, according to the preparation of the ground. On examination it will be found that each stalk will have several hundred feet of roots, frequently one thousand or more. The above is all on the supposition that all the requirements necessary for fitting the ground properly for the reception of the seed has been complied with, and also that a judicious selection of seed was made. It is as vain to look for best results in grain raising without care in selecting seed to propagate from as it would be to look for best results in raising stock of any kind without care in the selection of breeding animals. The same fundamental principle governs both.

The system recommended above is as applicable to other crops, such as sorghum, potatoes, etc., including the nursery and orchard. Also the small fruit and vegetable as well as to the corn crop, the primary object being to conserve the moisture and render the fertilizing elements in the soil available to the wants of the plants.

Secretary Sanborn called into question Mr. Bissell's theory that soil moisture is increased by tillage. It is now sufficiently shown that tillage prevents soil moisture from evaporating by forming a mulch. But the soil is warmer at night than the atmosphere above and really loses moisture at night. This fact I believe I have abundantly shown by trials carried on for a number of years and under different circumstances.

Mr. Murtfeldt followed with a talk on sheep husbandry.

Judge Hoskins, who was operating a woolen mill at Lebanon, was asked to state where he got his wool.

In reply he said he secured his supply from the farmers of adjoining country. Ten years ago, continued the speaker, we used only about one-third of the wool grown here. Last year we used all the wool grown in the districts. At first we only got native wool, but a few years ago several car loads of Canadian Cotswolds were brought in. These, however, produced too long a staple for our purpose, and lately a few fine wool sheep have been imported which give the wool our mill requires.

Ques. Have you increased the capacity of your mill, or has the amount of wool produced in this section decreased?

Judge Hoskins: There is not one-third as much wool produced now as was a few years ago. Our farmers say it pays, but the dogs have done away with our sheep. A farmer sold out his flock of seven hundred or eight hundred head a short time ago on this account.

Secretary Sanborn said that sheep were our most profitable domestic animals. Sir John B. Lawes found that one hundred pounds of food made eleven pounds of sheep growth and only nine pounds of beef, or of dressed weight about five pounds of each. The sheep, in addition to this, should give two cents worth of wool for every pound of meat. In the sheep, therefore, we have a most profitable animal under good management, or even under moderately good management. Why should dogs be allowed more liberties than men and be allowed to go where they please? Why not make the law force the owner to restrain his dog.

Mr. Nelson: I have lost as many as forty sheep in a single night by dogs. And while my sheep are near the house, yet in order to keep them from being killed, I have to make many dog funerals. I hope the Board will agitate the dog question. We followed one young man to his grave whose death was caused by the bite of a worthless cur. This young man was worth more than all the dogs in Missouri.

At this point the Board and those present were invited to partake of an elaborate and magnificent banquet prepared by the cultured farmers' wives of this enterprising community. It reflected great credit on their hospitality, energy and taste. While the labor required to carry forward to success such an entertainment was necessarily exacting, yet all seemed to so enjoy it as to leave no doubt of its healthy influence on the social side of farm life. Near three hundred persons sat down to the feast. After this the poor of the town were invited in to partake of the good things prepared, thus emphasizing the generous instincts of hospitality that prompted the banquet.

AFTERNOON SESSION.

Prof. Taft presented the subject of fruit culture. He was very favorably impressed with the great fruit growing capacity of this section of the State; that it would soon grow into one of the best fruit sections of the country.

Exceedingly fine samples of fruit, vegetables and grain, were on exhibition at the meeting.

Among other things, the speaker said it was not advisable to prune too much as it left the tree exposed to the hot sun. On the question of cultivation of orchards, he said that cultivated orchards gave a larger apple but a shorter lived plant than one in sod land well cared for. When, after the first few years from setting out, we keep the orchard in grass, we must see that a good and uniform growth is secured. To aid in this wood ashes is good. In packing for shipping use good clean barrels, well filled with carefully selected apples. The barrels should be filled so full that the head will not go in without considerable pressure, in order to prevent the fruit from rolling about and being bruised.

Ques. How long will the Jonathan keep?

Prof. Taft: If picked early it will keep until February.

Ques. Your advice is to set Jonathan and Ben Davis for market apples, is it?

Prof. Taft: Yes.

Ques. Can you change the bearing year of an orchard?

Prof. Taft: By removing the blossoms or fruit from young trees they can be induced to bear the odd year. Use ashes as fertilizer in the bearing year. This will increase the probabilities of a crop the next year. Canker-worm, by eating off the foliage, often change the year of fruitfulness.

Ques. What do you think of the Smiths cider?

Prof. Taft: I like it. Should place it as a fall apple. It is a regular bearer and the fruit is of good size and quality.

Ques. Would you pick before the apples are fully ripe?

Prof. Taft: Yes; a short time. Apples gathered as soon as the stem will separate from the fruit spur will ofter keep several weeks longer than if allowed to become fully ripe.

EVENING SESSION.

The first speaker was Mr. Murtfeldt on butter making.

Mr. Nelson favored the Cooley Creamer. He had used it in New York. He took some exceptions to Mr. Murtfeldt's statements in advocating the shallow pans for setting milk. Mr. Nelson claimed that in

order to get good butter from this system of setting it required a very uniform temperature, which is somewhat costly to obtain.

The Secretary said a few words of encouragement for co-operative dairying. In communities where the dairying is undeveloped, as is the case with many large sections of the State, and where local markets are not sufficient for the production, co-operative dairying will give a much more uniform product.

Mr Nelson requested that all who were in favor of extending an invitation to the Board to visit Lebanon again next winter would signify the same by rising. All arose.

The following resolution was introduced by Rev. Mr. Martin and passed by a unanimous vote of the house:

WHEREAS, The prosperity of a State or Nation is measured by the intelligence with which its agriculture is prosecuted;

WHEREAS, The income of the farms of Missouri is $15,000,000 to $20,000,000 annually, and the taxes of the State are largely raised upon these farms; and,

WHEREAS, Improved agriculture, while bettering our farm community by a well known law of political economy, cheapens the food of the consumer, thereby directly aiding every citizen; therefore, be it

Resolved, That this convention of farmers request the next General Assembly to appropriate sufficient money to enable the State Board of Agriculture to perform the full purpose of its organization for the encouragement of our agriculture, and especially to enable it to greatly increase the institute meetings over those now held, and to secure the best talent to assist it in this work.

MEETING AT MOUNT VERNON.

An Institute meeting was held at Mount Vernon, Lawrence county, Mo., December 31, 1887.

Secretary Sanborn opened the meeting by explaining its object—that it was held under the auspices of the State Board of Agriculture; that practical talks on topics of interest to the farmer were given, and

that he hoped those present would feel free to ask any questions or take a part in the discussions.

He spoke of the effect of the past system of farming on the fertility of our soil, and concluded by referring to the necessity of incorporating more grass and intelligence in the future agriculture.

Question: Our farmers have trouble in making clover catch. Will you explain how this can be remedied?

Prof. Sanborn: I sow with oats, the ground being thoroughly pulverized, and the seed sown early. It comes well and stands the summer well for me.

Ques: When the oats are cut does not the sun kill the clover? It does here.

Prof. Sanborn: A rich soil, well pulverized, produces a vigorous plant with long roots and it will stand the heat.

Ques: Farmers recognize the fact that wheat grown after wheat increases the crop. Why is this?

Prof. Sanborn: There is no such fact. On a virgin soil where organic matter is abundant the tendency of the first one or two wheat crops is to produce an over abundance of straw. The equality is soon restored, however, and the maximum crop may, other things being equal, be secured from such a soil after it has been grown in wheat for a few years. But after this the crop will decrease very rapidly.

Ques: We have not the means to make our soil rich with fertilizers and we wish to grow clover. How shall we secure a set?

Prof. Sanborn: By thorough tillage, early sowing and the use of good seed.

Ques: We do not succeed with it when sown with oats. Why not sow with wheat or some other crop?

Prof. Sanborn: My objection to sowing with wheat is that owing to the ability of clover to store up the elements necessary for a good wheat crop, I make wheat follow clover instead of clover following wheat. It may be sown alone if you prefer, but the crop of weeds that will spring up will be as detrimental as a crop of oats. Besides, good farming will allow you to grow a good crop of oats and secure a stand of clover at the same time. In this way you will not lose the use of your land one season, as you certainly would if clover were sown alone.

Ques: If your land will not grow clover, what then?

Prof. Sanborn: Sow it in buckwheat; follow with sorghum and then sow your clover, which will give you a good crop.

AFTERNOON SESSION.

Mr. Murtfeldt was the first speaker and read a paper on the "History of Our Cattle."

At the conclusion a discussion between Prof. Sanborn and the speaker on the relative value of meat from the different beef breeds ensued, in which Prof. Sanborn said that decisions of fat stock shows do not answer the question. The influence of feed on the quality of meat and proportion of fat to lean is greater than that exerted by difference of breed. By feeding one lot of steers with highly carbonaceous or fat-forming food and another on food rich in protein or muscle-forming food at the Agricultural College I changed the composition and marbling of the meat to a marked degree. (See bulletins 14, 19 and 27, to be found in the previous reports of this Board, for detailed information of the tests.)

Mr. H. J. Waters then presented the following paper on the "Relation of Grass to Soil Conservation:"

RELATION OF TILLAGE TO SOIL CONSERVATION.

BY H. J. WATERS, ESQ.

There has, perhaps, never been a time in the history of Missouri when the need for radical changes in our system of farming was more apparent to observing farmers than at present. The low prices commanded by farm products during the last three years, coupled with the fact that the average yield is constantly growing less, convinces us that a departure must soon be made. The chief aim in the past seems to have been to increase the acreage of corn, wheat and oats, paying but little attention to the improvement of grass and giving no thought as to the result of such methods. Reliable figures showing the yield per acre of these staple crops for our State during the past quarter of a century express in the strongest terms possible the disastrous effect of continually growing wheat after wheat or following one exhaustive tillage crop with another year after year. Dividing the twenty years extending from 1863 to 1883 into four periods of five years each, the average yield of wheat for our State, as returned by the United States Department of Agriculture for the first period, was fourteen bushels per acre. During the second period there was a decline of one and four-

tenths bushels, making the average yield for the five years twelve and four-tenths bushels. The average of the third is only eleven and nine-tenths, nor is this ruinous reduction checked in the fourth period, for the yield has fallen to eleven and seven-tenths. We observe a more marked decline in the yield of corn. The average of the State for the same periods shows a crop of 39.8 bushels for the first, 32.1 bushels for the second, 27.1 bushels for the third and 26.6 bushels per acre for the fourth. This uniform reduction extends to the present, and the average for the two years just past is only 23 bushels, a falling off of over 42 per cent. In the light of these facts we may properly ask what the result of this practice will be if continued for another quarter century. True it is, other States have or are now pursuing the same unwise policy, but however much company may console us in our sorrow, it certainly furnishes no practical relief.

It is, therefore, only a question of time—and I believe the time now is when the figures quoted above must be reversed. To accomplish this, radical changes must be made, and certainly no change is more fundamental in its character; none that will exert a greater influence for good; none more readily made; none requiring so little increase of capital, than that of reversing the relative acreage of grass and that devoted to tillage crops. This proportion measures the advancement of our agriculture. Abundance of grass is an essential element of high farming. This statement is most strikingly illustrated by comparing the agricultural systems of France and England. In France fifty-three per cent. of the tillable land is annually sown to some kind of grain, while in England only twenty-five per cent. is devoted to grain crops. Again, while France has but twenty-two per cent. of her tillable area in grass, England has fifty per cent. Notwithstanding this great difference in the amount of land devoted to grain raising, the yield per capita is almost identical in the two countries. The same lesson may be learned nearer home. We see the barren, rocky hills of New England and Eastern States where from fifty to seventy-five per cent. of their arable area is grown in grass, producing more bushels of wheat and oats, and more tons of grass per acre than the States of the Mississippi Valley with their supposed inexhaustible soil fertility. To ascertain the one great cause for the greater crops produced on soil incomparable in natural resources with our Western soils, it will be necessary to consider the injurious effects of continued tillage. The first question then will be the relation of

TILLAGE TO SOIL DISINTEGRATION.

A very small proportion of the elements essential to plant growth contained in a moderately fertile soil is available to the growing crop at one time. In other words, the plant food furnished by the soil is very slightly soluble in water—being locked up in stable chemical compounds. The plant is able to take up these materials only when dissolved in water. It is necessary, therefore, in order for a plant to grow in an unmanured soil, that a re-arrangement of the elements contained therein, a breaking down of these insoluble compounds must occur, making them partly soluble at least. Otherwise the plant must starve.

The forces exercised in this process of disintegration, which are more or less influenced by tillage are:

First—Free access of Air.—The primary object of tillage is to improve the texture of the soil. A more thorough circulation of air is by this means promoted as well as more surface exposed to its disintegrating influences. Again, air is condensed in the pores of the soil, the amount varying largely with its physical condition or the size of its pores. For example, the number of cubic feet of air, as determined by careful experiments, in an acre of soil of a forest taken to a depth of fourteen inches, was 5,891. The amount contained in the same area of an asparagus bed taken to an equal depth, was 11,182 cubic feet. Thus the finely pulverized soil of an asparagus bed contained nearly double the amount of air found in the undisturbed soil of a forest. Unfortunately we have no determinations of this kind for sod land, yet there is probably no great difference in this regard between it and the forest soil mentioned above.

The significance of these figures will be found in the fact that the introduction of such large quantities of air brings the particles of the soil in almost constant contact with free oxygen and carbonic acid. Free oxygen, the most active of all elements, decomposes the organic or vegetable matter of the soil, converting the nitrogenous compounds into forms available to the plant. In a similar manner the mineral ingredients are affected. Sulphuric acid often results from this action and in turn dissolves certain elements and places otherwise insoluble substances at the disposal of the plant. Large quantities of carbonic acid are liberated by this oxidation of vegetable matter. Hence, the air of a cultivated soil will, under ordinary circumstances, contain a much larger proportion of this gas than either a soil in which the decay of organic matter goes on more slowly or in an atmosphere above the

soil. In speaking of this question, Prof. Storer says: "The air in the pores of cultivated soils is highly charged with carbonic acid, as has been shown by the investigations of Boussingault and Lewy, and of many other observers, and the formation of it is no doubt promoted by all those operations of tillage which tend to lighten the soil or introduce air into it." This carbonic acid introduced directly from the atmosphere, as well as that formed and liberated by the decomposition of organic matter in the soil is largely taken up by the water present. By this means the solvent powers of the water are greatly enhanced. Substances practically insoluble in pure water are readily taken up by this water charged with carbonic acid. "Phosphate of lime, for example, though scarcely soluble at all in distilled water, is taken up in considerable quantity by water which contains carbonic acid."

The important action of oxygen in rendering available the nitrogenous constituents of the soil has been briefly stated in another paragraph, and to make the subject clearer will again quote from Prof. Storer: "Until a comparatively recent period almost the whole of the saltpetre (nitrate of potash) used in Europe, was produced in that country by artificial means. A mixture of loam, manure, marl and leached ashes, was thrown into shallow heaps or beds, which were sometimes even kept loose and open by means of racks and gratings. These heaps were moistened occasionally with barnyard liquor or with urine, and they were shoveled over at frequent intervals, pains being taken that air should be freely admitted to the interior of the heap. After some months of exposure to the air in this way the earth was leached methodically with water, and there was contained a quantity of nitrate of potash and nitrate of lime."

Second—Temperature.—This also exerts an important influence in soil disintegration. It places the molecules of the various substances contained in the soil into more intimate contact and chemical action is induced. For example, it has been ascertained by experiment that decomposition of organic matter proceeds very slowly at forty degrees Fahrenheit, is much increased by a temperature of fifty-four degrees, and seems to have reached its greatest intensity at ninety-eight degrees. Prof. Storer observes that the decomposition of rocks in the southern latitudes has proceeded much farther than is the case at the North, and that the soils are consequently deeper. The warmer climate of the South seems to favor this deep-seated disintegration, and it is true that comparatively warm water there percolates the soil throughout the year, and that carbonic acid is incessantly generated from the decay of organic mater. That is to say, some of the agents which work for disintegration are constantly active. Sir John B. Lawes accounts for the

great difference in the quantity of nitrates found in the soil between the spring and mid-summer months by the influence of temperature on oxidation. The temperature of a bare soil is higher than that of grass or sod land. The soil on which is grown our common tillage crops—corn, wheat, oats, etc., is bare for more than half the year. This is especially true of corn land. Thus it is clear that the season of active oxidation begins on these soils earlier in spring, is more intense, and continues later in autumn than in our meadows and pastures.

Third—Micro-Organisms.—Of this class of bodies comparatively little is known, yet it has been fully demonstrated that they act as ferments and materially aid in the decomposition of organic matter or hasten the process of nitrification. It is also known that this class of useful *germs* operate only in the presence of free oxygen. Thus the influence of tillage on these microscopic organisms is two-fold, for it opens the soil and admits the circulation of air, which furnishes them the necessary free oxygen. Also the mechanical operation of tillage serves to scatter the spores, to sow the seeds, as it were, in a new soil, where they soon multiply to such an extent as to appreciably forward nitrification.

Fourth—Double Decomposition.—I know of no experiments touching this part of the subject, but it is reasonable to presume that in a soil where chemical action is going on very rapidly if the physical condition is often changed by the mechanical means, the substances are continually being brought into new relations. It is then easy to conceive of two insoluble compounds being brought into such relations that an exchange of acids might occur that would render either one or both partially soluble at least. Under the next head will be considered the relation of

TILLAGE TO SURFACE WASHING.

The great waste from this cause has come under the observation of every farmer so often that it needs only a passing notice here. The value of a sod in preventing this waste has doubtless been proved by practical experiment by every farmer. Yet in making up the aggregate losses due to excessive tillage it will be well to bear in mind the fact that it is for the most part the finest and most fertile portion of our soil that is carried away by heavy rains. And by removing the forests and other natural protection from our soil and annually cultivating from 60 to 70 per cent. of our arable area we allow the Missis-

sippi River alone to rob us of 7,471,410,000 cubic feet of soil each year. The river Nile carries each year 3,700,000,000 cubic feet of soil, and the Ganges 6,368,000,000. To illustrate the bad effects of depriving the land of a protection, I again quote from Prof. Storer: "The fires of the early settlers have left many of the New England hills almost as bleak and bare as if nature had never been at the pains to cover them with soil and forest."

TILLAGE TO LEACHING.

There are other important losses of soil fertility not included in the above figures. In one of these is included that portion of the soil dissolved by water and carried either into the subsoil or passing out through drains, springs or other outlets for subterranean waters. This loss is largely nitrogen, one of the three elements most needed by our soils. While it is doubtless true that some of the nitrogen carried into the subsoil by this means is again brought within reach of the plant by the flow of capillary water, yet much of it is perhaps firmly fixed in the subsoil or carried beyond the reach of capillary water. The amount of plant-food passing out through drains has been carefully determined by many investigators. For illustration, the average results obtained from a large number of determinations extending over a period of several years at the New York Experiment Station under the direction of Dr. E. L. Sturtevant, is given. In each case the amount of water passing through the drains per acre was measured and the drainage water carefully analyzed. The determinations were for three parallel plats, one covered with grass sod, the second bare but not cultivated, and the third bare and cultivated. The amount of water passing through the drains of grass land per acre during the season was 40.38 tons. From the drains of the bare uncultivated soil there passed per acre 999.59 tons during the same length of time, while the drains of the bare cultivated plat yielded 1245.54 tons per acre. It was noted in the season of 1885 that water passed through the drains of the grass plat only during the months of April and December, a period of the year in which for reasons already stated, nitrification had reached almost its minimum intensity—whereas from the bare soils the greatest amount of water was obtained during the summer months or during a time when the disintegrating forces are most active. We are not, therefore, surprised to learn from the analysis of these drain waters that the drainage from the sod land contained only twenty-three grains of solid matter per gallon, and that the whole 40.38 tons that passed through during the year contained only thirty

pounds of nitrogen. That the bare uncultivated plat contained five hundred and forty grains of solid matter per gallon and 218.7 pounds of nitrogen, and that of the bare cultivated soil contained 456.8 grains solid matter and 218.2 pounds of nitrogen per acre.

While the amount of nitrogen lost by this means in the above experiment is greater than occurs in ordinary farm land as these plats were doubtless manured. Yet the principles involved and the relative quantities doubtless apply to any soil. The full importance of the above figures will be felt when we bear in mind that only about forty-two pounds of nitrogen per acre is removed from the soil in a crop of thirty bushels of wheat and its straw. Under the old system of manufacturing salt petre (nitrate of potash) described in another part of this paper, the salt petre was obtained by this process of leaching. The power of water to extract potash from wood ashes is well known. Precisely the same process of oxidation and leaching that went on in this heap of manure, etc., must go on to a certain extent in every cultivated field. Great as this loss is, it is rarely considered by farmers in estimating the cost of a crop of corn or wheat and conversely the profits of a grass or clover crop.

TILLAGE TO VOLATILIZATION.

The loss from this cause is also chiefly confined to nitrogen. In another place attention is called to the rapid decomposition of vegetable matter induced by the circulation of air. We have but few determinations of the extent of this loss, yet it is known that in many cases a loss, both of ammonia and free nitrogen, occurs. Boussingault found that horse manure lost almost two-thirds of its nitrogen by too rapid decomposition in the presence of air. The same principles are involved in the case of soils and that loss is sustained admits of no question.

Thus far we have spoken only of the losses resulting from tillage and of the conserving influence of grass. But the value of grass is not confined to this alone. Under the next head will be considered the relation of

GRASS TO NITROGEN ACCUMULATION.

There is a wide difference in the power of different plants to gather nitrogen.

Some crops have the power to gather this substance with apparent ease, and not only to supply their own needs, but even cause its accumulation in the soil. There are other crops which lack this

power and depend wholly upon the supply of this element already in the soil in an available form. Clover and our cultivated grasses are familiar examples of the former class, while wheat is a good a representation of the latter. In other words, on a field where only a half crop of wheat can be grown for lack of nitrogen, a crop of clover can be grown without fertilizers which would contain in its roots alone more nitrogen than the whole wheat plant required, besides a fine crop of hay, especially rich in this element.

The reason for this difference in the powers of plants to gather certain food, has not been satisfactorily explained, notwithstanding many of the most careful investigators have given much time and attention to its solution and that the data obtained has been formulated into theories by the most logical minds of our time.

Taking the two examples used above, and representing perhaps the two extremes in this regard, it may be accounted for by the different root development. In the case of wheat the roots are confined almost wholly to the first few inches of the soil. In this the nitrogen may have in a large measure been exhausted by previous cropping and leaching. On the other hand, the clover roots extending far into the subsoil feed over a much greater area and are enabled to draw upon the nitrogen left in the subsoil by water leaching through.

There are doubtless other causes, but the length of this paper forbids their consideration here. It is generally accepted, however, that clover has the power of gathering nitrogen from the air, and this is possibly true, to a certain extent, of some of the grasses. A considerable portion of the nitrogen gathered from the air and brought up by the deep feeding roots is left in the surface soil in a form that is easily rendered soluble. This, in a large measure, explains the value of clover and grass as a preparatory crop for wheat and other cereals which have a low power for gathering nitrogen. In addition to the accumulation of nitrogen the amount of organic matter is also increased and the physical condition of the soil greatly improved. By continued tillage the organic matter is burned out, the soil becomes hard and compact, runs together easily when wet, its water-holding capacity is greatly diminished, it cracks open in times of drouth, and is in many ways unfitted for successful farming.

Summing up the whole field, then, we find that opening the pores of the soil to air induces rapid decay, especially of organic matter; that this rapid decay furnishes soluble food faster than the crop can appropriate it; that this excess of available plant food is in part carried into the subsoil beyond the reach of the plant, and often below the capillary water, and is in part leached out of the soil entirely; that

rapid decay of organic matter in the presence of air is attended with a loss of nitrogen, either as a free gas or as amonia; that the nitrogen lost from these causes is, in many cases, greater each year than would be removed in a heavy crop of wheat or corn; that most of the heavy loss from surface washing each year comes from our cultivated fields, and represents the finest and richest portion of the soil; that the organic matter is burned out, leaving the soil in poor condition to stand drouths.

On the other hand, the grass crop retards soil decomposition by protecting in part the organic matter from the action of oxygen and carbonic acid, by retarding the action of the aerobic ferments, and by lowering the temperature.

A large portion of the water is evaporated through the leaves, which lessens the flow through the soil, and lessens to that extent the loss of fertility by leaching. Loss from volatilization is completely avoided. The thick mat of roots prevents surface washing. The physical condition of the soil is greatly improved by addition of organic matter, and fertility increased by the conservation and addition of plant food.

Prof. Taft was the next speaker and gave a lecture on orcharding.

Mr. Peck: We have much trouble with blight. What is the cause?

Prof. Taft: It is probably due to a late growth in the fall, induced either by cultivation or late warm rains; or the soil lacks some of the mineral elements necessary for healthy growth. Wood ashes furnish these elements in the proper proportion, and I find in them the best remedy for such ailments.

Prof. Sanborn: What should be the average yield of an apple orchard per acre?

Prof. Taft: One hundred barrels.

Mr. Murtfeldt: I saw a pear tree in Michigan over one hundred years old.

Prof. Sanborn: We learn something from Dr. Arthur's experiment in New York about the cause of pear blight. We know that a weak or poorly fed calf or man is more susceptible to disease than any other. This fact applies as well to the vegetable kingdom, according to the experiment just mentioned.

Question: How can we grow cherries and plums? The trees die or the fruit drops with us.

Prof. Taft: We cannot grow sweet cherries in this climate on account of the sudden and extreme changes of temperature. But I have no trouble growing sour cherries, and do not understand why

yours should die in winter. The dropping fruit is due to the work of an insect—the curculio. To get rid of them, make a chicken yard of your plum orchard. The fowls will destroy the insects. If this is not practicable, and you care to take the pains, spread a cloth under the tree and shake the tree early in the morning. The curculio will drop on the sheet and you can readily catch them.

Question: Why will not corn grow well after timothy?

Prof. Sanborn: Is it true?

Mr. ———: That has been my experience.

Auditor: I do not want a better crop than timothy to precede corn.

Mr. White: I broke up ten acres of timothy sod and raised fifty-nine bushels per acre this year.

In the general discussion that followed the prevailing experience was that corn did well after timothy.

Maj. Teal was called on for a talk, but being unprepared, declined.

Secretary Sanborn then gave a talk on "Seed Breeding."

Ques: Suppose the pollen from two varieties of corn are allowed to fertilize one shoot, what will be the result?

Prof. Sanborn: You will then have a mixture and not a cross.

EVENING SESSION.

Mr. Murtfeldt was the first speaker introduced, and gave a talk on the "Kitchen Garden." He recommended early planting and said that in order to get good vegetables they must grow fast. Plant potatoes as soon as the ground will work well. A frost sufficient to blacken the foliage will only detain them a few days. For full report of this talk see report of Charleston meeting.

Ques: Do you recommend the Champion of England pea?

Mr. Murtfeldt: I do.

Prof. Taft then followed with his lecture on "Insects Injurious to Vegetation."

Ques: What can we do to destroy the chinch bug?

Prof. Taft: Burn the trash and stubble in which they hide during the winter. If you fear an attack on your wheat early in the spring roll the crop.

Ques: How do you keep grapes from mildewing?

Prof. Taft: Spray the vines in the spring with a mixture of water,

lime and sulphate of copper, one-fourth pound of sulphate of copper and one pound of lime to a gallon of water. For grape rot the simplest and best remedy is to put a paper sack around each bunch.

Prof. Sanborn followed with a talk on "Grass Growing."

Mr. Peck: I move that Prof. Sanborn and the Board be tendered the thanks of this assembly for their visit, and that they be requested to return soon. Carried by unanimous vote.

MEETING AT NEOSHO.

An institute meeting was held at Neosho, Newton county, Missouri, January 2, 1888.

The meeting was called to order by Dr. Smith. The first speaker introduced was Prof. Sanborn, who gave his usual opening talk.

Question: I would like to ask Prof. Sanborn to state his system or order of rotation of crops?

Prof. Sanborn: Commencing with corn, this is followed with oats the second year, clover the third, wheat the fourth and timothy the fifth and sixth, which completes the rotation of six years.

Ques: Is it advisable to cut clover more than twice during one season?

Prof. Sanborn: I think not.

AFTERNOON SESSION.

Mr. H. J. Waters was the first speaker, and gave a talk on the relation of grass to soil conservation, which will be found in this report.

Prof. Sanborn took up the subject where Mr. Waters left off and discussed grass growing.

Mr. Farris: I have with me three specimens of grasses which I

consider as nuisances to Newton county. I should be pleased to have you tell their names and how to get rid of them.

Prof. Sanborn: Without seeing more of the plants than you have I cannot name them, but you can get rid of these pests by good cultivation and frequent rotations.

Dr. Smith: Some years ago I sowed a field in timothy and turned cattle in the field. The fall was dry and that grass near the gate where the cattle had tramped thoroughly came much better than anywhere else. I concluded from this experience that rolling is advantageous.

Prof. Sanborn: On light soils rolling is very often advantageous, but on the close, compact clays it is oftener deleterious.

Mr. Farris: At what time do you sow clover?

Prof. Sanborn: As early in the spring as the ground will work well.

Mr. ———: Your experiments have been made at least two degrees north of here. How much difference will that make?

Prof. Sanborn: A difference of two degrees would not materially affect the result.

Mr. Farris: If you sow clover seed in the fall that has been shipped from the north it will die, but if the seed is grown here and sown in the chaff it will be protected by the hull and come up in the spring if sown in the fall.

Dr. Smith: My experience has taught me that winter sowing is best for timothy and spring sowing for clover.

Ques: Does the wind carry any considerable amount of the best portion of the soil away when it has been plowed and pulverized for wheat in early fall?

Prof. Sanborn: I do not think sufficient soil is lost by this means to prevent tillage when necessary.

Mr. Farris: I have manured my meadows in the winter. Is there any better method?

Prof. Sanborn: If your ground is very rolling it would be better to plow the manure in, but if level, I am satisfied that will do very well. However, I will say that on meadow land the manure will do more good if worked in the soil than when applied on the surface.

Prof. Taft was the next speaker introduced, and gave a talk on "Small Fruits."

Mr. Farris: At what time would you gather winter apples to have them keep the best?

Prof. Taft: As soon as the stem will separate from the tree.

Ques: What is the name of the insect that lays the egg that hatches the worm that eats in the core of the apple?

Prof. Taft: The codlin moth is the worst one, and this can be prevented by spraying the trees in early spring with Paris green dissolved in water, one pound to 200 gallons.

Mr. Farris: Will not the solution af Paris green poison the grass under the tree and cause injury to our stock?

Prof. Taft: No; experiments show that when even fifty gallons of water is used to one pound of poison it will not hurt pigs.

Dr. Smith: Will this solution kill the caterpillar?

Prof. Taft: Yes.

Ques. What is the name of the insect that rolls up the leaf of the apple tree and lives there during the winter?

Prof. Taft: It is one of the class of leaf rolling insects, but there are one hundred and fifty different insects that prey on the apple tree, and I cannot give you the name of this one from your description.

Capt. Williams: Is the apple tree subject to blight the same as the pear?

Prof. Taft: Yes; the blight you speak of is either caused by the action of frost on the unripened wood, or the soil does not furnish sufficient and proper food for the tree.

Capt. Williams: I have a large pear tree that has grown well for ten years but will not bear. What shall I do to induce it to fruit?

Prof. Taft: Give the soil around it a good dose of unleached wood ashes.

Mr. Farris: The pear trees of this locality are nearly all dead. Can you give us a remedy that will help us in the future?

Prof. Taft: Plant them on poorer soil and use wood ashes freely.

Dr. Smith: Do you cultivate strawberries up to the ripening of the fruit?

Prof. Taft: No; I mulch and pull or cut out any weeds that come up afterward.

Dr. Smith: I saw an Arkansas apple at carthage, called the rock pippin, which they said would keep until June or July. Do you know anything about it?

Prof. Taft: I never saw it, but I have seen several varieties from Arkansas that were recommended as good keepers.

Mr. Powell: I would like to have the Professor's opinion of the lawver.

Prof. Taft: It keeps about as well as the Jonathan but is of inferior quality. The fruit is large and in some localities the trees are quite productive.

Auditor: I have some lawvers and find them to be excellent keepers and fine sellers.

Ques. Do you recommend training trees in a pyramidal form?

Prof. Taft: Yes; that form is quite good.

Dr. Smith: My neighbor does not prune his trees.

Auditor: A farmer near here would not prune his trees and his orchard is now a mass of brush.

Auditor: I think the pyramidal shaped tree grows too high for convenience in gathering the fruit.

Ques. Is there any borer proof wash?

Prof. Taft: Yes; any strong alkali mixed with a small amount of Paris Green will kill the borer before it can enter the tree. But it will not kill them after they are once in the tree.

Mr. Farris: I use a wash composed of one quart of slaked lime, one pint of coal tar, a small amount of sulphur, all mixed with about five times that amount of fine earth.

Prof. Taft: I don't think the wash you use is a good one as it fills the pores of the bark and will injure the tree. Tar is sure death to all plants.

Ques. How would you apply this wash?

Prof. Taft: With a white wash brush.

Capt. Williams: Will any wash kill the seventeen year locust?

Prof. Taft: No; as they work on the roots a heavy dressing of ashes might destroy part of them and would certainly be good for the trees.

Mr. Geo. Hatzfield, a prominent farmer and sheep raiser of Newton county, read the following paper on

SHEEP HUSBANDRY.

Fellow Farmers of Newton County:

I desire to address a few words to you on this very important subject. My remarks and conclusions will be based on carefully compiled statistics, the importance of which no one engaged in wool production or sheep raising will underrate.

For over six years I have been engaged by the United States Department of Agriculture at Washington City, and have also had the honor of reporting agricultural statistics of this county to our State Board of Agriculture for several years past.

As you are aware statistics treat of figures, and figures speak for themselves.

Comparing notes on the number of the various kinds of live stock in this county for the last five years, one item struck me as not being in accordance with the general development of this county. I refer to the number of sheep at the present time compared with that of five years ago.

In 1883, we had in Newton county in round numbers over 11,000 sheep. On January 1, 1888, we had only 6,832. During this period of rapid decline in the number of sheep, the number of cattle increased from 12,486 head in 1883, to 19,929 in 1888. Horses during the same period have gone from 6,422 head to 8,431.

Why is it, then, that the number of sheep has diminished at the average rate of 1,000 head per year, while the number of other live stock have been steadily increasing?

This led me to investigate the matter, and this is what I found: sheep raising, and with it the wool industry, received a death blow while in its infancy by the reduction of tariff on wool.

The following figures will bear me out in this assertion. Immediately following the reduction of tariff the decline of sheep husbandry began.

	Sheep.	Jan. 1, 1888.	Reduction during 5 yrs
In 1883 Missouri had	1,453,919	1,182,272	271,647
Ohio had	5,050,541	4,562,913	487,528
Texas had	7,877,500	4,761,831	3,115,669
New York had	1,732,332	1,579,866	152,466
Pennsylvania had	1,803,336	1,094,323	709,013

To this list might be added many other States, in fact all the older wool growing States show a heavy decline in numbers of sheep owned.

The total number of sheep in the U. S., according to the estimate of the National Department of Agriculture in 1883, was 49,137,291 head, estimated to be worth $124,365,835. In January, 1887, the number had fallen to 44,759,314 or a reduction of 4,487,977 head. But a still greater difference is noted in the valuation, for the value of all the sheep in the United States in 1887, was estimated at $89,872,839—a decline of $34,492,996, and this in spite of the rapid settlement of the Western States and Territories.

Now, if a reduction of tariff has been disastrous to sheep raising, what will happen if the tariff is taken off—a measure our administration favors at the present time?

It is high time for sheep raisers to inquire into this matter. The result of abolishing the duty on wool and woolen manufactures will be disastrous in the extreme. But it will not be the farmer alone that will suffer the consequence. There is one or more woolen mills in nearly every town of any importance. How would it affect them? In the far-off Southern countries of New Zealand, Australia and Queensland there are sheep owners whose flocks are innumerable, and to whom the cost of raising wool or mutton is comparatively nothing. These men are anxiously awaiting the day when this country will throw wide open its doors and admit their wool duty free.

American farmers will then find it impossible to compete with these Southern barons of free pasture and no taxes, and they will be forced to abandon sheep raising. In consequence, our inland woolen mills cannot buy their wool at home. The Eastern manufacturer, being nearer the wool market and seaboard, could manufacture woolen goods cheaper and could undersell the inland manufacturer. They could not compete with the East and Europe at the same time. It would shut down nearly every woolen mill in the West.

Our President says in his message that it would make little or no difference to the sheep owner if wool would be admitted free of duty, as he could make up when he buys his clothing what he loses on the price of his wool. But when the farmer has no wool to sell how will he make up the difference?

Farmers and farmers' wives, are you prepared to go back to the old spinning wheel and loom to make up your own flannels and common clothing? For, after our own wool industry is killed out, you will see the time when you will not be able to pay the exorbitant prices of the importer or Eastern manufacturer. History would but repeat itself.

I think it ought to be the duty of our Government to encourage and protect such an important industry instead of ruining it. This country is large enough and amply able to produce all the wool its people need, and has mills enough and workingmen to spin, weave and knit all that is required. Why, then, invite foreign product and labor? The raw wool of Europe is not as high in price, its laborers in woolen factories work twelve hours for the pittance of from 15 to 30 cents a day. They could import their goods to this country, but would we, as consumers, be benefited by it. Uncle Sam would have to pay the freight, and besides send his money over there, never to return, which he

could, by his protection, keep in his own pocket and pay out to his own laborers.

I don't know what our present Congress will do, but it would seem prudent for the farmers of the country to call the attention of their Representatives to the peril of the wool industry of the United States, and I think they would give it attention, and, if you would all work together, spoil the game of the importer and Eastern monopolist.

Dr. Smith: I think the yellow, bench-legged dog is the worst enemy to sheep husbandry.

Prof. Sanborn then gave a talk on stock feeding, which consumed the time before adjournment.

There being no train later than 5 P. M. on which the Board could reach Sarcoxie, the point for next day's appointment, no night session was held.

MEETING AT SARCOXIE.

A Farmers' Institute meeting was held in the Opera House at Sarcoxie, Jasper county, Mo., January 3, 1888.

The morning session was called to order by Mr. C. M. Rice, editor Sarcoxie *Vindicator,* who, in a few words, stated the object of the meeting.

Col. Rusk, a prominent farmer of that county and pioneer citizen of the State, was chosen chairman.

Prof. Sanborn was the first speaker introduced, who gave his usual general talk.

Mr. Waters followed with a talk on the "Relation of Grass to Soil Conservation."

Adjourned for dinner.

AFTERNOON SESSION.

Secretary Sanborn opened the exercises with a talk on "Grass Growing."

Col. Rusk: I wish to ask if the meadow foxtail you refer to is our common cornfield foxtail?

Prof. Sanborn: No; I mean *alopecurus pratensis*. The head resembles that of timothy; it has a dense mat of leaves and ripens very late in the summer.

Question: I would like to ask if you have ever tried more than one kind of red clover?

Prof. Sanborn: Yes, but I prefer the ordinary variety.

Ques: I understand that you do not use any other grass with your clover?

Prof. Sanborn: You are correct. I am determined to follow clover with wheat, and find no advantage in growing grass with it, while I do find it advantageous to follow with wheat. Besides, we cannot grow clover successfully oftener than once in four or five years.

Ques: Will alfalfa do well as far east as this?

Prof. Sanborn: Yes, on a dry, open soil, with an open subsoil.

Ques: Would you pasture wheat?

Prof. Sanborn: I have never had experience in this question, and would not like to advise.

Ques: Is it the time of cutting clover that causes slobbering among horses?

Prof. Sanborn: Yes.

Prof. Taft followed with a lecture on "Orcharding."

Ques: Do you cultivate ground in the spring that you mulched in the fall?

Prof. Taft: No, I mulch sufficiently in the fall to completely cover the ground. This prevents the ground from getting hard or weedy. In case the mulch was too light to accomplish these objects, I cultivate.

Ques: Would you do that cultivating early in the spring or later in the season?

Prof. Taft: Any time will do, but the earlier the better—cultivating shallow.

Mr. Rice: Would you advise planting an orchard on recently cleared wood land—sowing the land down to clover and not cultivating?

Prof. Taft: I think that would be perfectly safe, provided you keep the trees growing constantly and uniformly.

Ques: Will not coal aahes answer as well as wood ashes for the purposes you mentioned?

Prof. Taft: No.

Ques: When would you apply the ashes?

Prof. Taft: Early in the spring or any time, in fact, except in the fall, when a late growth might be induced by their application.

Ques: Will not large quantities of unleached ashes injure the tree?

Prof. Taft: No; yet they will not do as much good as when scattered.

Ques: Do you have any preference between hens, hogs and sheep in an orchard?

Prof. Taft: Hens cannot possibly do any harm, and will do much good, especially if the codlin moth is working on the fruit. The same may be said of sheep, provided there is plenty of food in the orchard. Otherwise the sheep may injure the trees. Hogs are more sluggish, and will not get the apples as soon after they fall as will sheep or chickens. This interval allows the worm time to get out of the apple and seek a safe retreat, where it will develop into a moth to injure the later crops of apples.

Prof. Sanborn: I saw an orchard in which one hundred hens were kept. The grass was kept down to the ground and the chickens were fed. The orchard made for the owner that year $1,000 net profit.

Mr. Wilde: I fear the $1,000 would come out on the other side of the account some years if sheep were kept in the orchard.

Mr. D. J. Bissell, of Iowa, was the next speaker, and gave a talk on Shallow Culture of Corn. For synopsis of his remarks see report of Lebanon meeting on pages 174–176 of this volume.

Adjourned for supper.

EVENING SESSION.

Meeting called to order by Col. Rusk at 7:15 P. M.

Prof. L. R. Taft was the first speaker introduced. He gave his usual talk on Insects Injurious to Vegetation, which will be found in this report.

Prof. Sanborn followed with a talk on Breeding and Feeding Cattle.

MEETING AT SHELDON.

A Farmers' Institute meeting was held at Sheldon, Vernon county, Mo., Wednesday, January 4, 1888.

Meeting called to order by Mr. G. M. Wyckoff, who presided during the meeting.

Prof. Sanborn was the first speaker introduced, and gave his usual talk outlining the work of the meeting.

Mr. Waters followed with a talk on Relation of Grass Crop to Soil Conservation, which will be found in this report.

Ques: What mode of applying manure do you recommend?

Prof. Sanborn: This will vary for different seasons, but on the average you will obtain more pounds by plowing it under. This increase will be mainly in straw, however, and the relative weight of grain to straw will be greatest when manure is applied on the surface.

Ques: Do you not think the manure that has been plowed under will be of most value the second year?

Prof. Sanborn: Yes.

Auditor: I find that by putting down a layer of manure and then a layer of soil, and so on—covering the whole with soil—I get much the best results.

Prof. Sanborn: If you apply manure in the fall plow it under, and very little will be lost by leaching. If applied after the ground has thawed out in the spring, but little will be lost when applied on the surface.

AFTERNOON SESSION.

Prof. Sanborn opened the session with a talk on Grass Growing, covering much the same ground as does the opening article of this report.

Ques: What varieties of grass do you recommend?

Prof. Sanborn: Any list that I could give would need to be modi-

fied and varied, according to climate and soil. But the following is a list of grasses that promise well: Timothy, meadow fescue, orchard grass, Rhode Island bent grass, meadow foxtail, Kentucky blue grass, Enlish rye grass, and red, white and Alsike clovers. These furnish more food at all times of the year than any other crop can.

Prof. Taft followed with a talk on Fruit Culture.

Ques: Do you think pears will ever succeed here?

Prof. Taft: Yes, if grown with care, not over cropped, not tilled when the soil is wet and left unstirred when dry. If grown on poor land and fed on wood ashes, they will succeed.

Mr. D. J. Bissell of Iowa, was the next speaker. He said that as Prof. Sanborn had crowned grass king, he should claim for corn the position of queen. And as this was intimately associated with woman, the sweetest name in the English language, he was perfectly satisfied. He then proceeded to discuss the subject of Shallow Tillage of Corn, and treated it much in the same manner as reported at the Lebanon meeting.

MEETING AT APPLETON CITY.

A farmers' Institute meeting was held at Appleton City, St. Clair county, on Thursday, January 5, 1888.

Meeting called to order by Mr. Ava E. Page, Secretary Missouri State Grange, who presided during the entire meeting.

The exercises were opened with prayer by Rev. H. M. Hackney of Appleton City.

Mr. S. C. Sturtevant was called upon to deliver the address of welcome. He said:

It gives me great pleasure to extend in behalf of the citizens of Appleton City a most cordial welcome, both to the distinguished gentlemen who have come from a distance and to the farmers of this vicinity who have gathered to meet them. We all are, or at least ought to be, social creatures by nature, and little pleasure is felt by a human

being when isolated from his own kind. But when kindred spirits meet, the signs of pleasure are unmistakable.

The cordial grasp of the hand, the glad bright light of the eye, and the hearty salutation show that the parties experience mutual sensation of pleasure.

In addition to this we hope that the farmers here may, by the counsels of our professional speakers, and advisers, and by a mutual discussion and interchange of ideas, gain knowledge that may be to them of substantial financial advantage, and we are far from being entirely unselfish in this.

We are aware that the propserity of the town depends almost entirely upon the prosperity of the farmers; that theirs is the occupation upon the product of which the members of every other craft, trade and profession depend as a means of subsistence. Let the farmer cease for a single year to plow and plant, what wide-spread ruin would speedily overtake all other industries. The steam would be shut off in mills and manufactories; the hammer of the mechanic would lie silent; the rumble of the cars would no longer be heard; ships would lie rotting in idleness at the wharfs; the pen of the ready writer would rest for want of use; schools and colleges would be closed; inventors would abandon their half-formed achievements; the human race would retrograde toward barbarism, and from every part of the earth would be heard the same wild despairing cry for bread.

Holding thus the key to the world's storehouse, and with the prosperity of the whole human family depending on their efforts, how utterly inexcusable are the farmers, if they fail to properly appreciate their advantages and duties, and to attempt to improve themselves and their methods of management whenever an opportunity offers.

Not feeling qualified or desirous of offering for your consideration any remarks concerning the details of any branch of your work, I will content myself by simply saying that we are rejoiced to greet you and hope you may find that it is good to be here, and that a feeling of the cheeriest good will and hearty sociability will pervade at this meeting.

Hoping that this will be the feeling of all participating in this Institute, I will close by saying again to our visitors welcome, welcome, thrice welcome to our midst.

The Secretary responded to the address of welcome endorsing all that was said of the importance of agriculture, and then gave his general opening talk.

AFTERNOON SESSION.

Prof. L. R. Taft opened the session with a talk on "Fruit Culture."

Ques: Can currants be grown here?

Prof. Taft: Yes, if grown in partial shade of a tree or a fence, but they are not profitable here.

Ques: Which do you regard the best, the Soughegan or Hopkins?

Prof. Taft: The Souhegan.

Mr. Speer: I have found the Hopkins twice as prolific as the Souhegan.

Mr. A. Falcon, an enterprising farmer near Appleton City, read the following paper on

FALL PLOWING AND SHALLOW CULTURE FOR CORN.

At this age of sharp competition and low prices, we must get the most work possible from the least number of teams and hands which can only be accomplished by fall plowing. Again, by a number of years of careful observation I find that the number of days wherein to plant corn to secure the best results are limited to about one week. If we wait to do our plowing in the spring, it not only requires more teams, but generally the best time for planting is past ere we are ready to commence planting, and then perhaps with worn down teams; but if done in the fall we are ready and waiting and should commence to prepare the ground as soon as danger of frost is over, in fact be planting some part of the crop, finishing up in good time just when many are wishing that they were done plowing, so that they could plant a piece of corn. And when corn tilling time comes and weeds appear or not, teams are vigorous and strong, able to crowd the work along; in fact are ahead in a catching season. Again, on fall or winter plowing one can usually plant from one week to ten days earlier, because the warm surface soil remains on top to plant the seed in, while in spring plowing one turns the warm soil down and the cold up, thus endangering the germination of the seed. Again, a week or ten days gained, nearly always means a large yield of good sound corn. In a section of country where we have no system of rotation or manuring and fertilizing our soil, but are constantly and eternally trying to raise corn on an

improverished and famished soil, fall plowing is somewhat of a substitute for a system of rotation because of the benefits derived from the green trash plowed under and the action of the elements during the winter. To show the value of green trash plowed under, a neighbor plowed a part of his oat field early in the fall, before frost, on very old land likely to run together in the spring, and the remainder he plowed in the spring, planting in corn three or more years and that piece of fall plowing had the best corn on it the entire time. I myself plowed one acre of flax stubble in August, intending to plow the whole piece for wheat, but was prevented in so doing, and plowed the remainder of the field in the winter, not re-plowing that acre in the spring. I planted my corn across that strip, and all summer and at gathering time that acre was the best in a field of one hundred acres; that yielded sixty bushels of shelled corn. So I might cite dozens of cases in the past twenty years of actual practice and observation.

I am well aware that some have failed to secure the best results on fall plowing in the past season, but it is the first failure of the kind I have ever heard of and perhaps the only time it has ever occurred to them, or that they have ever heard of the like in their lifetime, and perhaps they are as gray as rats; and at once, without due inquiry or investigation, perhaps loudly condemn fall plowing.

Now this opens up the subject of what is the right way and time to plow corn so called.

It is not every one who can guide a team and hold the handles of a cultivator that knows how and when and when not to plow corn so as to be sure of something more than a crop of poor cornstalks. I hope to show that it was not fall ploing that prevented these people from securing a yield of corn, but rather their wrong tillage and the wrong time at that. Perhaps some of you have seen what is called a tree digger, a kind of plow used to run along a row of yearling trees and Osage orange plants to loosen them and cut their roots so that they may easily be pulled up and put in bunches for market. Now these people made partial tree diggers of their cultivators, and failed to tie up what good stalks they then had, and failed in the fall to get either corn or good corn stalks. Remember that all roots furnished plants by nature are for some purpose, and that purpose is to sustain the plant, and enable it to mature its foliage or fruit of its kind, and that if you destroy the roots, of course you cut off its source of life supply, and stunt it so it cannot mature its fruit, more particularly in seasons like those of 1886 and 1887, which were unusually dry. Fall plowing permits a closer and deeper tillage than trashy or spring plowing, the surface being more finely pulverized, thereby cutting

off many of the corn roots, which in a wet season would not have been noticed, or done the same amount of damage.

DON'T PLOW YOUR CORN DEEP.

A neighbor, a very nice and exact farmer, checked his corn so nicely that he was enabled to cultivate it zigzag or angling across, and he did so; the rows were closer that way, and up to that time it was the finest field of corn anywhere; but from then on it failed, and yielded less than the average when it should have been much the best. And another dug his up, so to speak, with those famous bull-tongues last year, and consequently had a small crop. I might go on and give twenty or more cases in the past eight years where a fine crop prospect was destroyed, just for want of thought and observation on the part of the owner or cultivator. Don't suppose for a moment that I would not have you till your corn, for I say till from sun up to sun down, and keep tilling if necessary, but till systematically and intelligently, and avoid the following dangers:

For this season under the present condition of the land, don't plant too thick; don't plant seed exposed to alternate thawing and freezing; don't plant seed unless you know it will grow; plant only seed enough to secure from two to three stalks in a hill and no more. And be sure that you have a variety best suited to your soil, and no matter what kind your friend may grow, if the soils are not just the same. You should secure your seed corn early in the fall and store in a dry place. Also remember some kinds of corn will waste its time and strength in growing to stalk. Always check row your corn, as it is proven by twenty years observation here that it will stand drouth longer, and costs a great deal less to keep the weeds down. It is too expensive to rely much on a hand hoe. One cannot commence to cultivate too soon, the earlier the better; and whatever number of times you may cultivate your crop, don't lay it by too soon, or don't plow it too near the time of tasseling out. While it may not damage it much in a very wet season, in a dry one like the past it will. The oftener you cultivate it, up to a certain stage of growth, the better, if not too deep. And more particularly remember that in this vicinity, in the past two years, strong new land, or timothy or clover sod, have not failed to give remunerative crops of corn in spite of the drouth and bugs, while old land run to corn for years was a failure, so to speak. Again remember that in a lifetime of the practicing of the butchery system of the cultivation of corn, you have not been able to change the habit of the plant to throw out its tiny rootlets in search of food to

supply it with substance to grow to perfection.. Then stop partially digging it up every few days, as much so as you would avoid partially digging up potato vines or your orchard.

Ques. When shall we lay corn by?

Mr. Falcon: Before it begins to tassel.

Ques. How many times shall we plow it?

Mr. Falcon: As often as is necessary to keep down the weeds.

Ques. Do you favor early planting?

Mr. Falcon: Yes.

Ques. What kind of corn shall we use?

Mr. Falcon: I like the ninety day corn.

By the almost unanimous wish of the audience, Prof. Sanborn talked on grass growing. [See opening article of this report.]

Mr. D. J. Bissell of Anamosa, Iowa, followed with a talk on Shallow Culture for Corn. For synoposis of his remarks, see report of Lebanon meeting.

EVENING SESSION.

Notwithstanding that it was raining, a very large audience assembled—completing this meeting as one of the most important held in the State. The morning session was largely attended, and a large body of very intelligent men assembled at the afternoon session. A lively interest was manifested and the closest attention was paid to the lectures.

The speakers of the evening were encouraged by the local band, while recitations and singing spiced the proceedings.

Levi Chubbuck, B. A. S. Agricultural Editor *Colman's Rural World*, read a paper on Farm Water Supply.

This was followed with a very creditable recitation by Miss Nellie Adams entitled, The Palmetto and the Pine.

Prof. Sanborn then addressed the audience and took occasion to express his gratification at seeing so many ladies present. The Board had made efforts to induce ladies to attend these meeting and features of special interest to them had been provided, but so far with little success. Without the co-operation of woman farming could not be successfully carried on, and they are as deeply interested in what constitutes good farming as are the men. Especially are they interested in

all that pertains to the farm home, which has been so much neglected in the matter of labor-saving implements and household conveniences. No pains should be spared to make the farm home comfortable, pleasant and refined.

The remainder of the time consumed by the speaker was devoted to the consideration of stock feeding.

This was followed with a recitation entitled, An Old Farmer's Discourse to his Son Tom, by Miss Ella Streater, which elicited hearty applause.

Prof. Taft talked on Insects Injurious to Vegetation, prefacing his remarks by quoting the statement of a farmer and orchardist present, to the effect that the time was near when no one can successfully grow fruit without understanding the habits of the common insect pests. The speaker fully endorsed the sentiment quoted and proceeded to discuss the question proper.

"After the conclusion of these remarks a vote of thanks to the State Board for the meeting was passed and the Board invited to return at an early day. Prof. Sanborn returned thanks for the vote and for the cordial reception tendered the visitors. He took occasion at this point to express his gratitude for the beautiful boquet sent from the *Journal* office, and complimented the editor, Mr. C. C. Hilton, for the interest he had manifested in this meeting."—*Rural World.*

Great credit is due to Ava E. Page, Secretary State Grange, and the local newspapers for the earnest work done to secure a good meeting.

The Board finds that the success of its meetings is largely dependent on the efforts of local managers and organizers.

MEETING AT WINDSOR.

An Institute meeting was held at Windsor, Henry county, Friday January 6, 1888.

The shower of the preceding night continued and had developed into a pouring rain storm.

Under the circumstances only one session was held, which was in the afternoon.

To the surprise of the speakers on repairing to the hall they found about sixty intelligent farmers assembled.

The Secretary, Prof. Taft, Dr. Paul Paquin, State Veterinarian, and Mr. Bissel gave their usual talks.

Owing to the fact that the talks of three sessions were crowded into one, no time was given to questions or discussions. Yet the audience paid close attention and gave every evidence of a lively interest, and despite the fact that rain poured down rapidly a good meeting was held.

MEETING AT SOLEVILLE.

A Farmer's Institute meeting was held at Soleville, Cooper county, Saturday January 7, 1888.

The rain storm that militated against the Windsor meeting on the day previous had changed to sleet and permitted the Board to hold only an afternoon session. The Speakers had driven twelve miles over rough roads through the storm to meet their engagement and were greeted by an audience of about fifty persons—a much larger crowd than could have been expected under such discouraging circumstances.

The Secretary gave the opening talk, and, as usual, discussed the grass crop, the subject invariably chosen from a number summitted by the speaker, when left to a vote of those present.

Dr. Paul Paquin, State Veterinary Inspector and Professor of Veterinary Science at the State Agricultural College, presented the subject of stock breeding.

Mr. Levi Chubbuck, Agricultural Editor *Colman's Rural World*, followed with a general talk on the relation of education and organization to the material prosperity of the farming classes. In the course of his remarks the speaker reviewed the farmers' reasons for neglecting their agricultural education, for neglect it was since they did not

improve the opportunities offered by the State Agricultural College and various good agricultural papers.

Prof. Sanborn then presented the subject of stock feeding.

This was followed by Dr. Paquin, who by request, gave a talk on hog cholera. For a full presentation of the subject see report for 1886–87.

Again the usual questions and discussions were crowded out on account of lack of time.

Thus closes the sixteenth meeting of the year, and the last one that the funds of the Board permitted.

Never before in the history of the Board has there been such a demand for these meetings. Those held in southern and southwestern Missouri have been very well attended by intelligent and enthusiastic farmers, and the future of this work in our State never presented a more promising and flattering outlook than now.

INSECTS INJURIOUS TO VEGETATION.

BY PROF. L. R. TAFT, B. S.,

Professor of Horticulture in the Missouri Agricultural College, containing the substance of a lecture delivered before the Farmers' Meetings held during the winter of 1887–8.

I have seen somewhere a jingling rhyme which, after alluding to the fact that all animals have one or more parasites preying upon them, concludes with the couplet,

> And the fleas have other fleas to bite 'em,
> And so on, *ad infinitum*.

True as this is with the animal kingdom, it applies with even greater truth to plants. Root, stem, branch, bud, leaf, flower, fruit, each and all have their own and particular insect foes. To such an extent have they become troublesome, that the apple tree, in its various parts, has more than one hundred and fifty distinct species of insects to contend against.

It is, perhaps, owing to their size that so little is known about insects, but it is probably true that not one person in a thousand can tell the difference between a bug and a beetle, or in fact, who supposes that there is any difference. Most people suppose that the small flies are the young of the large ones, and that the young flies hatch directly from the egg. On the contrary, the small flies are full grown, and instead of a perfect insect being developed directly from the egg, they pass through a transformation, as it is called, and between the egg and the perfect insect there are two intermediate forms.

Let us first see what an insect is. We may define them to be animals whose bodies are made up of a series of rings or segments, and which have jointed legs and feelers. All true insects have six legs

and have the rings composing the body arranged in three groups or body segments, known as the head, chest or thorax and abdomen.

The chest consists of three segments, which bear one pair of legs each, and the two hind ones generally bear wings. Insects are air breathing, their lungs being mere air sacks, with small breathing holes along the sides of the abdomen and branches running through the body.

For purposes of sight, insects have two large compound eyes and generally three simple ones. The compound eyes are made up of from a few hundred to several thousand small eyes, each perfect in itself.

Their sense of touch is most developed on their antennæ or feelers and legs, which are covered with fine hairs.

In most insects the seat of touch is in the organs surrounding the mouth, although in the cockroach and in a kind of fly, the nose is in the tail.

Some grasshoppers have their ears on their abdomen just behind their wings, and in others they are on the legs. The noises produced by insects are generally produced by rubbing together different parts of the body.

Insects seem to show great foresight in depositing their eggs, as they always place them upon or in close proximity to the substances which they feed on as larvæ. Many insects pass the winter in the egg form, and as they are so sealed up that they are impervious to moisture, they are uninjured by the severest winters. At the proper time the egg hatches and the young insect appears. In most cases it has a worm-like form and is called a *larva*. In this stage they are sometimes, as in the bee, without legs, but generally they have three pairs of true legs, from five to eight pairs of prop or false legs, except the measuring worm, which has but two pairs. While most insects pass but a few days or perhaps weeks in this form, one, the so-called seventeen year locust, lives for nearly seventeen years as a larva.

During this period the insects are very voracious and spend most of their time eating. As they increase rapidly in size, they soon outgrow their clothes; the old suit splits along the back and the insect steps out in a new suit which it wore under the old one. This at first is soft and allows the larva to increase in size, but it soon is too small for them and it is shed a second time. Many insects cast their larval skins five or six times.

When ready to transform to their next or pupa a stage, the insect prepares a covering for itself. It may enter the ground and make a cocoon of earth, lining it with a fine web spun from the under lip;

others, like the silkworms, spin silken cocoons within which to transform, while still others, as many butterflies and moths, secrete a tough chitinous covering which answers the same purpose.

The pupa stage is one of rest during which the wings, legs and other organs begin to take on a more perfect form. Most insects pass the winter in this form, but in many of the others it lasts but a few days. The insects which have wormlike larvae are said to have a complete metamorphosis. The so called "bugs" and "grasshoppers" on the other hand have but an incomplete metamorphosis, that is, the larvae and pupae in general appearance resemble the perfect insects; the wings, however, are wanting and many of the organs are imperfectly developed.

When the imprisoned insect has passed the allotted time in its pupal covering it emerges and assumes the perfect or imago form. In a short time the wings and body harden and it is ready for work.

The duration of life of the winged form of insects varies fully as much as does that of the larvae and pupae, some living but a few days while others, particularly the higher orders, may prolong their existence for several years. As a rule, however, we may say that the imago or perfect insect only lives long enough to develop and deposit eggs for a new brood. While some species are quite voracious as imagoes, others partake of but little or no food.

In order to intelligently carry on war against insects it is necessary to understand their habits and particularly their mode of obtaining food.

The insects which are of greatest interest from an economic standpoint may be divided into beetles, bugs, butterflies, bees, grasshoppers and the two-winged flies, but for our present purpose the first three divisions only need receive our attention.

The beetles are called *Coleoptera* (sheath winged) by scientists from the fact that their front wings are thick and hard and serve as shields for the hind wings. The inner edges of the front wings are straight and meet in a line along the back. The larvae of beetles are commonly called grubs, and are provided with strong biting jaws. The perfect beetle also has its biting jaws highly developed.

The bugs or *Hemiptera* are often wingless, but when the wings are present the front part of the fore wings are generally thick and opaque while the hind wings are transparent. In some cases the front wings are transparent while the hind pair is much reduced in size. All of this order have a slender tube through which they suck their food. When not in use this tube or proboscis rests in a groove along the under side of the body. The *Hemiptera* includes the plant lice and the

chinch and squash bugs, all of which suck the juices from plants and animals and are quite destructive both as larvae and as imagoes.

The butterflies and moths make up the order *Lepidoptera* (scale winged) so called because their wings are covered with delicate scales. The larvae are known as caterpillars or worms, which are especially injurious to the farmer, as different species feed on every part of plants. The perfect insects of themselves do little or no harm as they live but a short time and only suck the nectar from flowers. Their mouth parts are very weak, the food being taken in through a long slender tube which is carried when not in use in a close coil beneath the head.

INSECTS OF THE ORCHARD.

APPLE ROOT LOUSE. *(Schizonema lanigera.)*

This pest is most common upon the roots of trees grown in exhausted soil and on those which have over-borne, while a dry summer seems favorable to their development. They are bugs, and suck the juices from the roots of the trees, causing swellings and a weak, unhealthy growth. Sometimes they crawl up the trunk and can be found on the slender branches. Those living on the branches secrete a cotton like covering and are known as the wooly lice.

When a tree is attacked by them the best thing that can be done is to stimulate the tree so as to promote a vigorous growth. This can easily be done by plowing and cultivating and applying some form of fertilizer, wood ashes being among the best. From one to five bushels per tree spread over the ground for a space as large as the tops of the tree will not fail to produce a good result. The insects on the branches can be killed by spraying with coal oil emulsion or strong lye. Oftentimes trees are obtained from nurseries which have their roots infested with root-lice. They should not be planted until the lice have been killed, which can be done by dipping the roots in water warmed to 150 degrees F. or in lye water.

BORERS.

The trunks of apple trees are infested with the larvae of two species of beetles known as the round and flat-headed borers.

The flat-headed form, *chrysobothris femorata*, is most common at the West. They are about three-fourths of an inch long, dark brown in color and can be frequently seen during May and June sunning themselves on the south side of the tree. The borer itself has a broad and rather a flat head and a slender, tapering body.

About June first the female deposits her eggs on the trunk, generally near the ground, preferring young trees which have rough bark, as this forms a means of attaching and of concealing the eggs. In twelve or fourteen days the eggs hatch and the larvae eat their way into the soft wood; there they remain for nearly a year, feeding during the summer and passing the winter in a resting state at the bottom of the burrow. Oftentimes there are a number in one tree and they soon completely girdle it. When the larvae is full grown it assumes the pupa form and in about three weeks comes forth as a perfect beetle. The presence of the borers can easily be detected by the droppings which have been pushed out of the small holes through which the young borer entered the tree, or by the dark color of the dead bark which covers their tunnel.

When borers are in a tree the only thing to be done is to dig them out with a sharp pointed knife. Having thoroughly searched for and killed all the borers, in case much of the bark was cut away, the rough edge should be cut away and the soil banked up over the wound. If properly attended to, however, no borers will ever get into a tree. The beetle seldom deposits her eggs on trees which have been painted with some alkaline solution. Soft soap dissolved in water, so that it will be like thick paint, and strong solutions of lye or of washing soda are used for this purpose. To make doubly sure, however, I prefer to paint the trees about the middle of May with the following preparation: To ten gallons of strong lye made from wood ashes add one pound of glue dissolved in warm water and one-fourth pound of Paris green. The alkali, besides being a fertilizer, will generally keep the beetle from laying the eggs, but if any eggs are laid and hatched the Paris green will kill the young borers as they attempt to eat into the tree, while the glue holds it fast and prevents the rain from washing it off. Moreover, this forms an effective and sure remedy against rabbits and mice. As this borer is sometimes found in the crotches of the tree, not only the trunks but the crotches and larger branches should receive attention. Before painting the tree the loose bark should be rubbed off.

ROUND-HEADED BORER.

The beetle of the round-headed borer, *saperda bivittata,* is a little larger than that of the flat-headed form. It is very common in the East, but has done less injury in the Western States than the flat-headed form. They are of a brown color, with two narrow white stripes on the fore wings. They are seldom seen as they only fly at night. In its habits it is much like the flat-headed form, except that it passes

three years in the tree; and its ravages can be prevented by the same remedies.

CODLIN MOTH. (*Carpocapsa Pomonella.*)

This insect, as its name indicates, is a moth, and it is its larvae which are found in wormy apples. It is of foreign origin, but it has spread to all parts of the country, and unless some insect foe appears, the fruit-growers of the country will have no marketable fruit if they do not enter into a determined warfare with them. Soon after the the fruit forms the moth appears and lays a single egg in the calyx or blossom end of the fruit. The egg hatches in six or eight days, and the little worm eats its way in to the core. In about three weeks the larva is full grown, it gnaws a tunnel to the side of the apple. Generally the fruit has by this time dropped to the ground, but if it has not the worm either lets itself down by a thread which it spins, or crawls down the branches. They find some hiding place, frequently under the rough bark of the tree, and there pupate. In about fifteen days after the cocoon is formed the perfect moth appears, and by the first of July the eggs for a second brood are laid. Further south there are three broods in a year, the last one being picked with the winter fruit. Towards spring they leave the fruit and spin a cocoon and come forth as a perfect insect at about the time of the blossoms. After the larva has entered the fruit there is no remedy. The best remedy to prevent their gaining access to the fruit, is by syringing the trees as soon as the blossoms fall with a solution of some arsenical poison, and repeating this every four weeks up to July 15. This should not be done, however, on the early fruit within four weeks of the time of ripening. This method of fighting this most troublesome pest has been tried for a number of years in New York and New England States, and when properly done has never failed to be effectual. The California orchardists also systematically spray their trees, and by this means alone are they able to obtain marketable fruit. Paris green, London purple and white arsenic are used for this purpose, and all are efficacious. Paris green is but slightly soluble in water, and has to be constanty stirred to prevent its settling to the bottom, yet it has proved to be more effectual than London purple, although the latter costs less, is more soluble, and being lighter is more easily suspended in the water. White arsenic is still more soluble, and is cheaper in the end than either of the other, as only one-fourth as much need be used. It makes a colorless solution, and on this account is objected to by some who claim that there is more danger in its use, as it might easily be mistaken for pure water.

One pound of Paris green or London purple, or one-fourth of a pound of white arsenic is amply sufficient for 200 gallons of water.

The solution can be more easily made, however, by the addition of a bucket full of lye for each barrel of water, and some dissolve a pound of glue per barrel of water in order to prevent the poison from being washed off.

The poison is applied by means of a force pump, having a short hose with a nozzle at the end.

For a small orchard a small pump costing from $5.00 to $10.00 will answer very well, but the owner of a large orchard will find it economy to have a larger pump, as this will throw two streams, and perform three times as much work as a smaller one.

Placing the barrel of poison in a wagon, one man can pump and drive and another can manage the hose. With a fine spray every part of the tree will be reached, and at the time of the first spraying the calyx end of the apples will be uppermost, and will be filled with the poison liquid. The water will soon evaporate, and the fine particles of the poison will be deposited.

If an egg is deposited and hatched on a syringed apple, the young worm never lives to enter the fruit. It may be that the very contact of the delicate skin of the young worm with the poison will be sufficient to kill it. At any rate, if it tries to eat into the apple, it will be certain to get hold of particles of the arsenic and will die in the attempt.

This method is so efficacious that it seems almost unnecessary to mention any other. In case the trees are not properly syringed, and the small fruit begins to drop, the keeping of chickens, hogs or sheep in the orchard for a few weeks will cause great numbers of the worm to be destroyed.

The amount of poison used is so small that no one need fear to apply it, although as they are deadly poisons every precaution should be taken in their use. It has been figured that a person would have to eat five bushels of apples at one sitting in order to have any effect produced. While it would be best not to pasture stock in a syringed orchard, yet if the work was properly done there would be but little danger.

CANKER WORM. (*Anisopteryx Vernata.*)

This insect is in some parts of the State quite destructive to the leaves of the apple, elm, linden and other trees. They are moths, and the female is wingless. The winter is passed as pupae in the ground three to six inches below the surface. On warm days in winter, or in the

early spring, the perfect insects appear, and crawling up the branches deposit their eggs. Soon after the leaves open, the eggs hatch and the young larvae soon consume the soft portions of the leaves, leaving only the hard ribs.

The first attempt to control them was to trap the females as they ascended the tree, using troughs filled with coal oil, or bands of tarred paper coated with tar or printer's ink. These did the work, but as they required frequent attention, during three or four months they were rather costly. The syringing with arsenical compounds is now quite generally used, and if thoroughly done whenever the presence of the worm is noticed is the cheapest and best method.

APPLE CURCULIO.

In addition to the larvae of the codlin moth, the apple curculio does much harm. The perfect insect is a small beetle about one-fourth of an inch long, and has a snout which projects forward and downward. The eggs are deposited on the cheek of the apple, under the skin, the hole made being of the shape of a half moon.

The larva on hatching eats its way into the core and practically destroys the fruit. Apples infested by the curculio or gouger can be told from those containing the larvae of the codlin moth, as the latter enters at the calyx and the former on the side of the fruit.

No efficient remedy has yet been found. The beetles can be jarred down upon a sheet, but as they are rather lively, one has to be quick in order to catch them.

If the infested fruit be fed to hogs or sheep, the larvae will be destroyed.

THE PLUM CURCULIO.

This insect is not a serious injury to the crop of plums, but it is also injurious to the apple and other fruits.

The greatest difference between it and the apple curculio, is that the snout when not in use is drawn back under the head. It is also quite sluggish in its habits, especially in the cool of the morning.

The egg is deposited about as is that of the apple curculio, but after depositing the egg the beetle makes a crescent shaped cut around it, thus, ⌒, in order to check the growth of the portion over the egg so that the egg will not be crushed and to cause a softening of the flesh, so that it will be better suited for the food of the young larvae.

The plum curculio are easily caught upon sheets and destroyed. They can be jarred down by shaking the trees. By driving a spike into the tree or by cutting off a branch and pounding them with a mallet. Sometimes a sort of wheelbarrow carrying a frame for catching the curculio and a block of wood well padded, which is pushed against the tree, is used.

The Wild Goose and other Chickasaw varieties are not much troubled by this beetle, but it is practically impossible to raise the finer European varieties unless the curculio is destroyed.

The growers who have been most successful in obtaining crops of plums, combine with it the raising of chickens, using the plum orchard as a hen yard, and the chickens take care of the curculio.

INSECTS INJURIOUS TO GRAIN CROPS—CHINCH BUGS. (*Blissue Cocopterus.*)

The true chinch bug confines its ravages to plants belonging to the *Gramineae* or grass family, but there are other species which are sometimes quite destructive that feed on other plants.

This insect is about one-fourth of an inch long, and belongs to the Hemiptera or bugs. The perfect form passes the winter in the stubble, or other rubbish, and in the spring enters the ground and deposits her eggs upon the roots of the plants.

The larvae, after hatching, feed for a time on the roots, sucking out the sap. As they attain their growth they come above ground, and proceed to suck dry the wheat, corn or other grasses.

If the ground is rolled firmly in the spring, the bugs will have more difficulty in entering the soil to lay their eggs, and as the bugs choose the dryer spots for depositing eggs, rolling would probably have its effect in the conservation of the surface moisture. When fields are infested, the burning of the stubble will surely destroy all of the insects upon it. Mild and dry winters and springs seem especially favorable to their development.

When, as often happens, if they are abundant, they move from one field to another, they can he stopped by setting boards up edgewise and sloping outward, and tarring the edge. If postholes are dug along the outside of the barriers every few feet, and the insects being stopped by the tar, will turn aside, and many of them will fall into the pits.

HESSIAN FLY. (*Cecidomyia destructor.*)

This insect also belongs to the *Hemiptera.* The perfect form expands its front wings about half an inch, the hind wings being much reduced in size.

They generally appear in April and place their eggs on the leaves of the young plants. The larva soon hatches and crawling down the stem and the sheath of the leaf, sucks the sap from the plant, causing the joint to swell, and finally the death of the plant.

They soon pass through the pupa state and appear ready to lay their eggs on the winter wheat. Sometimes a third brood of insects appears in October.

When wheat is sown early and the bugs appear in great numbers, the crop can be turned under and the field resown. The second crop of insects will thus be destroyed, and there will be but little danger from a third crop.

The field may be pastured during the fall, and this, of course, will destroy large quantities of them. Heavy rolling will have the same effect.

WHEAT MIDGE. (*Diplosis tritici.*)

The midge greatly resembles the Hessian Fly, but the eggs are deposited in the heads of the wheat. The larvae are hatched out and begin at once to feed on the sap, thus causing the heads to shrivel.

Some of the larvae transform in the ground, and deep plowing will bury them so deep that they cannot get back to the surface.

JOINT WORM. (*Isosoma hordei.*)

In some localities this insect is quite destructive to grain crops, and is often taken for the Hessian Fly. The "Joint worm," however, deposits its eggs *within* the stem, and the larvae live in the interior instead of on the outside of the stalk. When they change to the perfect insect they come out of the gall in which they have lived through a small round hole. Burning the stubble is often practiced to rid the old fields.

ARMY WORM. (*Leucania umpuncta.*)

For one hundred and fifty years this insect has been known to be destructive in some localities.

The perfect insect is a moth, and in the spring the female lays its eggs on the inside of the grass blades.

At first the larvae are much like cutworms in appearance and habits. Their bodies are distinctly marked off into squares by means of black lines.

The worms hide during the day, and feed at night. If they become excessively numerous they are obliged to seek fresh pastures, and this has given them the name of "army worm."

INSECTS OF THE GARDEN.

The cabbage, perhaps, is as much infested with insects as any of our vegetables. About the time the early plants are ready to be set out what is commonly known as the "black fly," attacks them, eating the soft part of the leaves. By sifting ashes or land plaster over them while the dew is on, their ravages can be checked. Pyrethrum or the Persian Insect Powder is sure death to the fly. There are also several kinds of cabbage worms which greatly injure the crop.

The European form is most destructive. It is distinguished from the common cabbage butterfly by having two black spots on each of the fore wings.

There are several broods in the course of the year, and in most parts of the State if the first crop is not destroyed the late cabbage will very likely be much troubled by them.

The moths can be caught in nets and killed, or as the worms appear, pyrethrum will be found to be a certain remedy. Slug shot is also a good remedy.

The cabbage louse is becoming very numerous upon late cabbage. As it sucks its food, no application to the plants will kill it, but the coal oil emulsion kills by contact and if used in time will destroy it.

It has now become so that it is almost impossible to save cucumber plants from the "striped beetle."

They roost on the hills awaiting the appearance of the young cucumbers and lucky is the plant that escapes them. A frame one foot square, covered with mosquito netting, will keep the beetles off. Paris green mixed with 100 times its weight of flour or land plaster sprinkled over the vines while wet with due will destroy all that attempt to eat up the plants.

Sometimes after the plants are partly grown they will wilt and die. The striped beetle has deposited its eggs in the vine, and the attack of the larvae causes the death of the plants. If the beetles can be killed by the Paris green of course there will be none to lay the eggs.

The squash bug sometimes appears in vast numbers and destroys the plants. They can be killed by the coal oil emulsion or can be trapped by scattering a few shingles around among the plants. During the heat of the day the bugs conceal themselves under the shingles and can easily be killed.

In general we may say that if grasshoppers or the larvae of butterflies or beetles are to be fought against they can be destroyed by use of the poisons, provided they are not feeding on plants, some parts of which are to be soon used as food. For such, and for all kinds of sucking insects, pyrethrum or coal oil emulsion should be used. The emulsion is formed by churning together one pint of coal oil with a quart of milk or a pint of soft soap, and adding ten or fifteen gallons of water, the quantity to be according to the nature of the plants on which it is to be used, the correct amount to be ascertained by experiment.

Paris green when applied dry should be mixed with one hundred parts of flour or plaster of paris. In a solution one pound is enough for from fifty to two hundred gallons of water, according to circumstances.

THE FARM WATER SUPPLY

BY LEVI CHUBBUCK, B. A. S.,

Agricultural Editor *Colman's Rural World*. Read before the Farmers' Institute Meeting at New London, Kirksville, Cora, and at other places.

When one sees how little attention is given by the farmers of Missouri to the Farm Water Supply, it would seem as though they but little appreciated the importance of this fluid which covers more than three-fourths of the entire surface of the globe, constitutes more than three-fourths of the weight of all green vegetation and of all living animals. Indifference in this matter may have been induced, partly by the very abundance of the article and the frequency with which it is made to fall alike upon the just and the unjust, the apparent uncontrollable character of its coming, and largely from the fact that most of the inhabitants of this State or their immediate ancestors came from those sections in which springs and running brooks are so plentiful that nearly every farm has a never-failing natural supply of good water for stock and domestic purposes. When the people of Kentucky, Virginia, Pennsylvania, New York and New England left their little hilly and rocky farms and came to the broad and comparatively level plains of the West, they were forced to leave some advantages behind in exchange for those they expected to find in their new homes. The numerous springs of pure water and the sparkling brooks, which are a usual accompanyment of a broken surface and a rocky soil, were among those things which had to be exchanged for more fertile and easier worked land.

In moving from a section where nature furnishes to the farmer a continued supply of water to one where she has been less indulgent in this regard, and does not escape, in any measure, from the needs of the element, he simply goes where he must aid nature in supplying his

wants. That few farmers do not sufficiently co-operate with nature under the new conditions, but few, I think, will deny. Fifteen years on one farm in North Missouri, and opportunities to see and know of many more in different parts of the State, has confirmed me in the belief that while the farm water supply is one of the most important matters connected wich the farm, it is on 99 farms out of 100 the most neglected. Many have been the barrels of water I have hauled in times of drouth for use in the family; and how often have my "noonings" been taken up with the time required to take the teams off a quarter or half a mile to drink, the hired men and others resting in the meanwhile. Then in winter when the thermometer was registering anywhere from the freezing point to away below zero, how often have I driven the stock a mile and more away to the creek for their daily drink.

But while it is such things as these that cause many boys to become disgusted with farm life and to seek their fortunes in the towns and cities, much to the disadvantage of the country by thus losing the most stirring and energetic young men, it will be necessary to present to many farmers other disadvantages due to an insufficient farm water supply. Many will give less attention to their boys than they do to their stock, and home would be more easily stirred up to making provision for what they raise to sell than to efforts looking toward making farm life more attractive and pleasant for their own flesh and blood. Let us see how a short water supply affects the farm stock. As has been remarked, three-fourth of the weight of animals is water. This, however, indicates to but slight extent the amount of water needed.

All nutriment of both plants and animals must be in a fluid or gaseous state before it can be made a part of the organic structure. The great solvent of nature is water.

In order to digest and assimilate the grass, hay and grain which is fed to stock there must be enough water drank to dissolve it, with the aid of the digestive apparatus and substances, and then serve as a carriage to float the food to the different parts of the body where it is needed.

Another important service that water performs in the animal economy is in evaporating through the pores of the body. This is going on over all parts of the body at all times, even in the coldest weather. It is, of course, invisible in cold weather, but should the process be stopped by any mechanical means, or by some derangement of the system, death will follow shortly, unless the cause of stoppage is removed. About as much weight of moisture is evaporated from the skin and through the lungs as is discharged as

urine. When these facts are considered it will be seen how important it is that farm animals have an abundant supply of water. There is, it is true, a certain amount of water in all the foods given to animals; even dry hay is 14 per cent. of water; 75 per cent. of the weight of green grass is moisture, while some of the roots commonly fed to stock contain as high as 90 per cent., and the use of these more succulent foods obviate the necessity of as much water as when dry food is fed. This, in fact, has been advanced as one of the arguments in favor of the growing of more roots for winter stock food, they furnishing both food and drink. This may do to a limited extent, but water can be provided in a cheaper way than by growing turnips.

Admitting the necessity of an abundant water supply, the question now is, how to meet the demand.

THE SOURCE OF SUPPLY.

All the water of springs, wells, brooks and rivers is what has fallen on the earth's surface in the form of rain or snow, and has then found its way into the depths of the earth or into the streams and thence into the lakes and seas. The rains come from the moisture that is being constantly evaporated into the air from land and sea and every living thing. Thus is this circulating medium of nature kept in constant motion, performing its purpose, now here, then there.

> The drop of dew that trembles on each leaf or flower
> Is but exhaled to fall anew in summer's thunder shower;
> Perchance to shine within the bow that fronts the sun at fall of day,
> Perchance to sparkle in the flow of fountains far away.

The difference in the quality of water is due to the foreign matter that has become incorporated in it. The purest water as found in nature is that which comes from the clouds after rain has fallen a few hours and cleared the air of dust, soot, etc. This may sound like heresy to many who sing of the "Old Oaken Bucket" and its sparkling contents brought from the depths of the earth, but it is a fact, nevertheless, that many a well, the waters of which look so pure and are so cool and refreshing, are a source of disease and death. Water, in passing over the rocks and through the soil, must dissolve out some of the ingredients. Some of these may not be injurious, others often are. The hardness of water, a bad quality, is due to its taking up some of the substances of the soil. But the danger from mineral impurities is small compared to that from organic. The intelligent hearer need not be reminded of the hundreds and thousands of cases of death due to

poisoning of wells through decaying vegetable and animal matter getting into the water. This need not be due to carelessness, for often the impurities come from a long distance and in a manner hard to trace. The water, too, will look as pure as crystal, and, to the habitual users, be agreeable to the taste. But when an unaccountable death or two takes place in the family an examination of the well water often shows that here was the cause of death, and that it was not a mysterious stroke of providence. I do not mean to be understood as condemning all wells, but want to show that they may be a source of hidden danger. A well that affords an abundant supply of wholesome water is something which farmers could well afford to spend a good deal to secure.

As intimated, the water of wells came from the clouds, and when it reached the earth was the purest furnished by nature. Can we not save this in its approximate purity in abundance?

From 24 to 36 inches is given as the average yearly rainfall in this country. But a comparatively small area is necessary to collect enough water to meet the wants of not only the family, but the stock as well.

There has been and still is a prejudice against using rain water for household purposes, but this is fast disappearing. Stockmen who have used both well and cistern water will say, too, that stock do better when they have soft rather than hard water to drink.

A dwelling of the size needed by a farmer's family will have roof enough to catch all the water needed by the family if it be all saved; and the barns and sheds required to shelter all of the stock the farm can carry, with the winter's supply of food, and the necessary tools to run the farm, will give nearly, if not quite, roof space enough to catch all the water the stock will need during the time it is not in the pastures.

Admitting that water direct from the clouds is as good or better than after it has passed through the soil and dissolved out mineral matter, and that the quantity is sufficient for all purposes of the farm, if gathered and stored, it seems to me that the country abounding in wells and springs has not so great an advantage over us after all, for in the greater part of this State the cost of cisterns is not so great as that of wells, especially when the latter have to be sunk through strata of rock. The cisterns can be put where they will be the most convenient, and as they are usually more shallow than wells the water is more easily got from them.

The usual form of cisterns, circular, measuring from six to ten feet across and from ten to twenty feet deep is, perhaps, as good as any for the house, though other forms can be made cheaper than this.

A cistern ten feet across will hold for each foot in depth 18.65 barrels of water. Ten feet of water in such a cistern would be 186 1-2 barrels, or for 20 feet 373 barrels, more than enough for one barrel per day for family use. A house with 1200 feet of roof space, the amount on a 30x40 foot house, would catch in the course of the year about 600 barrels of water, and but little additional roof, say from wood shed, ice house, etc., would be necessary to increase the amount to enough to furnish two barrels per day for family use, an amount, in my estimation, adequate. Of course the cistern need not be large enough to hold this full amount, the rains being, as they are, distributed through the year.

An adjunct to the underground cistern which I would strongly recommend is a water tank in the upper part of the house. Such a tank can be readily put into many houses now built, and when a new one is being put up this point should be well considered. Having a capacity of 20 or 30 barrels, placed under the roof and connected by pipes with at least all of the rooms on the second floor, it would prove a great convenience, and would also be a safeguard against fire. Such a tank might be so located and made as to receive the first of the rain, and when the roof has become thoroughly cleansed the water could then be turned into the ground cistern. The tank water can be used for bathing and washing purposes, and being connected with the cistern by a force pump could be replenished when exhausted.

Cisterns for stock water can be made of a different form from those at the house, which it is desirable should be quite deep so as to keep the water cool. The barn cistern need not be over 10 feet deep, may be rectangular in form, say 10 or 15 feet wide and as long as is thought desirable. Such a cistern can be dug with a team, plow and scraper with but little hand labor, except in the walling. In respect to cistern walls: in our western clay any wall that will prevent caving in is all that is needed. A cavity in this clay will, ordinarily, hold water as surely as a jug. If, however, the cistern is sunk in porous soil, then a cemented wall must be built.

The length of this paper will not allow me to go into the details of cistern construction, and it must suffice to say that they should be made so that no water from the ground surface can enter, and no vermin get in. It should be so that it can be easily entered and cleaned out, and yet be so that children and animals cannot fall in. In walling up, the walls should be arched at the top and clay be filled in by and over it, and tamped down. A good pump is also a necessity in a well or cistern. The open well curb from which the aforementioned "Old Oaken Bucket" is so often drawn, is an abomination. It is a constant menace to the lives of the children and a source of anxiety to

parents, and serves as a catch-all for dust, leaves, sticks, milk pail and contents, rats, mice, kitten, etc.

Close it up and put in a good force pump, which will be easier to draw water with than with bucket and windlass. In the days gone by when the women folks drew all of the water for household use, it did not make so much difference, perhaps, but in these days of more advanced civilization when the men folks try to make the burden lighter for their wives, sisters and mothers, it will be necessary to have an easy working pump for the men to use, or what will suit them still better, a wind mill, which will pump the water into the house tank.

BREEDING OF GOOD PAYING, HEALTHY STOCK.

BY DR. PAUL PAQUIN, M. D., V. S.,

State Veterinary Inspector of Missouri, delivered at Farmers' meetings held at Appleton City and Soleville.

The man who raises stock naturally desires and hopes to get good paying animals. When he breeds a mare he wishes to get a fine colt; when he breeds cows he wishes results that will make him some money. And so on in the various species of stock. Yet how very few seriously study the problem of breeding from a sound basis. How many trust to what is conveniently called luck. In fact, most of people seem to believe that the result of breeding can hardly be controlled to any beneficial extent. It is an error. The raising of stock can be more or less influenced by man for better or for worse from the moment the male and female are coupled.

It is a matter of business, based upon a scientific foundation. It is this scientific foundation, therefore, that man should understand to raise stock intelligently. Let us then study the subject.

HEREDITY.

By heredity, as you all know, is meant the transmission of certain things by parents to their immediate or distant offsprings. This is so in civil life, and it is so in animal life. Thus a father and mother transmit certain of their characters to their offsprings. In this application to breeding the laws of heredity may be divided into three sections:

1st. *The individual heredity power.*

2nd. *The ancestral heredity power.*

3rd. *Consanguineous (or family) heredity power.*

By the individual heredity faculty is meant the power of any individual to produce offsprings with characters like its own. For example, we frequently see stallions producing colts like themselves in the great majority of cases, no matter what mare they had been crossed with. The knowledge that certain breeding animals of both sexes, especially males, have proven that they possess this heredity reproductive power is of the greatest value to whoever wishes to direct the generation of animals for profit. In fact, it is the most important one in ordinary cases where a good individual has to be crossed with a scrub. In such an occasion we should always select a first class animal; that generally produces its like to a great extent. Circumstances are such, that as a rule, this should be looked for in the male, for there are more scrub female animals than males kept for breeding purposes.

The ancestral heredity power (atavism) is known to have had influence on the young when it presents characters that existed in the grandparents (more or less remote), and which were not present in father or mother. For instance, a calf or a colt appears occasionally that presents characters that neither father nor mother possessed, but that some ancestors had. The evidences that such retrogradations occur are not uncommon, but can hardly be applied successfully, and with much benefit, if any, in breeding stock.

Finally, the family or consanguineous heredity power is that which is shown by the constant reproduction in a given breed of animals, of special points and characters that have existed in it since its origin, or that have been acquired early in its history. It is mainly by the intelligent application of this power that the striking uniform characters of Hereford, Shorthorn or Jersey cattle respectively; and Clydesdale, Norman, Cleveland Bay horse respectively, have constantly reproduced the characters proper to their special breeds since their origin. This law, it is obvious, is easily controlled by intelligent *in and in* breeding, which is so praised by many and so severely condemned by others, whilst it is beyond a doubt, one of the most useful to consult and follow *wisely*, for the production and reproduction of good characters that have existed since long in certain strains of animals and in creating new artificial breeds. Indeed, I may say at this point that to produce pure stock of a definite breed, breeding with close relatives or in-breeding frequently must be resorted to. And why does it fail and produce occasionally puny, sickly, and perhaps, consumptive subjects? Leaving aside a few exceptions, it is because in coupling the subjects the director of such operations did not make a wise selection. And what is a wise selection for in and in breeding, you may ask?

It is one in which no weak point exists in either the male or female, and especially the selection of subjects that do not possess similar weaknesses, defects or disease. For if by the individual heredity power of which we have first spoken, an animal may produce its like, how more surely when bred together, will two individuals possessing the same characters, good or bad, may produce their like. You frequently hear that this and that family are consumptive families. Exactly, and the poor constitution was brought about (except in acquired cases) by breeding poorly constituted individuals, thereby bringing into play both the individual and family heredity power. On the other hand, it is plain to see that under the influence of the same powers, breeding of close relatives having *no bad qualities*, will produce good stock as a rule.

It is not possible in a short paper to give all the means and ways to apply these principles of breeding, however, and I shall confine myself from this point to a narrow but very interesting part, that which heredity laws play, concerning the health and soundness of live stock. I will endeavor to explain the means to prevent the generation of weakly, unsound and diseased animals and of animals prone to various maladies.

The heredity laws, I need not explain further, stand true regarding the reproduction of bad as well as of good points. But there are certain defects which are so commonly reproduced by heredity that they have been called heredity defects, whilst others are seldom reproduced in the young, and still others of an accidental nature are probably never transmitted by heredity. Thus we see that in the ignorance of what is and what is not hereditary, it were better never to breed weakly, ill-conformed, lame or diseased subjects. Indeed, this were the safest policy always. But in some respects it is too sweeping, and to adopt it would work hardships to the limited breeders and the farmers who have limited means. For instance, a bony callous at the region of the hock joint, due to a fracture, is not an hereditary defect, whilst a spavin, which is a bony tumor, apparently of the same nature, and which is located on the same articulation, is considered hereditary. Thus, as a general rule, most of affections accidentally acquired are not hereditary in their nature, with the exception of a few which become so after the malady has made a deep impression on the constitution.

Taking everything into consideration, the following diseases should always be considered hereditary: Consumption (or Tuberculosis), periodical ophthalmia (or moon-eye so called), spavins, ringbones, chronic navicular disease (coffin point lameness).

The following are the cases of the doubtful class. Some authors call them inheritable with no mean show of reason, whilst others equally conscientious doubt the assertion. From this dissension of opinion it is wise to avoid breeding stock that present the characters that I will mention. It were always better to take the benefit of the doubt. These defects are:

Asthma (or heaves).
Roaving (of horses in the throat).
Crib-biting (or sucking wind).
Chronic founder with narrow chest.
Stringhalt.
Splints.
Big jaw (osteo-porosis).
Crooked tail and crooked legs.
General weak constitution.

We could not insist too much on avoiding ill-shaped and weakly subjects. Their offsprings may be weakly, and if they inherit no disease directly they may remain prone to numerous ordinary affections, such as colics, pneumonia, etc. In conclusion I should insist again on avoiding totally the breeding of horses from subjects with so-called moon-eye, spavins, ringbones and consumption. As to moon-eye our stock present now so many cases that if breeding is not guarded we will ere long have difficulty in finding colts and older horses that we may safely depend upon regarding vision. At a tender age I find them all over the State presenting the symptoms of that periodical ophthalmia. Breed no blind horse in fact—male or female, but especially the former.

It is well to remark, perhaps, before closing, that the defects of the male are more constantly reproduced, comparatively speaking, than that of the female. The reason is that the male is generally chosen on account of its individual heredity power, which therefore influences the majority of offsprings.

Castrate all scrub bulls and colts, and spay all scrub heifers and thus get more marketable stock of them and make a start towards the regeneration of the nation's herds throughout the land.

SOME NEEDED CHANGES.

BY M. W. B. HARMON, ESQ.,

Member of State Board of Agriculture from Nodaway county.

There seems to be an imperative necessity on the part of many in this State for a change in the methods of farming as now practiced, a demand for more broad minded farmers familiar with the elements of improved agriculture and horticulture, and with farm engineering and animal industry, history of agriculture, rural law and landscape gardening—fully imbued with the faith that red clover is the great land renovater and natural fertilizer, its crops more profitable in themselves, and of almost unlimited importance in restoring, retaining and conserving the fertility of the soil, and especially in the direction of a diversity of crops and the raising of the various improved breeds of live stock and poultry.

The custom of the cultivation of the same crop on the same land year after year tends to the multiplication of insects injurious to the crop and the rapid exhaustion of the fertility of the soil. An intelligent rotation of crops best suited to the soil and climate should be encouraged and more generally followed. For instance, the following nine years' rotation of crops would be found profitable on most prairie farms: First year, sod plowed and sowed to millet or sorghum for fodder, replowed in July and sowed to turnips, replowed in November for corn; second year, corn fodder cut up and ground, replowed for oats; third year, oats and clover; fourth year, clover, plowed in fall for winter wheat and timothy; fifth year, fall wheat and timothy; sixth year, timothy hay crop and pasture; seventh year, the same; eighth year, cattle fatted on the grass; ninth year, sheep fatted on the grass, with all the manure the farm affords well harrowed in. This rotation makes sheep as important a factor of profit as cattle, horses, hogs or dairy products,

all of which should find a place in the economy of the farm in intensive farming. Sheep are almost as valuable and necessary as the plow in conserving the fertility of the soil and destroying the noxious weeds that choke out the regular crops and should be sent through every field during the growing season as often as the crops occupying the several fields would admit to crop the weeds before going to seed.

With such a system of crops and grazing, sheep kept in flocks of from 50 to 100 can be made the most profitable live stock kept on the farm. Mutton can be raised for two cents per pound and wool for six cents, but the great drawback to any intensive system of farming in which wool and mutton are a factor is a law upon our statute books, not to protect us against the cheap Russian, Australian and South American wools, not the tariff of 1867 or 1883, but a law to protect the sheep from the hordes of useless and worthless dogs that roam without restraint and destroy the sheep at their leisure and pleasure. In the year 1886 Missouri is reported to have 1,182,272 sheep, valued at $1.67 for revenue purposes. In the same year 17,000 sheep are reported to have been killed by dogs, valued at $50,000. In most counties in Missouri sheep are restrained by law from running at large; in every county the owner of sheep may be held responsible for damage done to growing crops; in every county of our State dogs are permitted to run at large to prey upon sheep or anything else they may find to destroy. In 1886 there was reported in Missouri 3,876,325 hogs, valued at $3.26 for revenue purposes. These hogs are in most counties restrained by law from running at large, while each county in this State maintains from 500 to 5,000 dogs as freebooters to prey upon whatever their hunger or vicious habits dictate.

While there is no authentic data upon which to estimate the number of dogs in the State, the damage done by them or the cost of their maintenance, yet when we come to reflect that most families in the State are supplied with from one to two dogs we are almost forced to the conclusion that it costs us more to maintain the luxury of our dogs than it does the sheep, and almost half as much as it does to maintain and fit our hogs for market besides the damage done by them to our poultry, hogs and sheep—important factors in improved methods of intensive and profitable farming. Therefore a law that will tax dogs as other domestic animals are taxed for revenue purposes, restrain them from running at large, and hold their owners responsible for the damage done by them, seems to be a "military necessity" if we ever lift our agriculture from the ruts and grooves in which it has been in the habit of running to a more diversified, intensive and profitable system.

WARINGTON'S CHEMISTRY OF THE FARM.

The Secretary is most happy to announce that he has secured from Orange Judd Company, of New York, well known publishers and importers of rural books, the privilege of publishing in this report Warington's Chemistry of the Farm, a dollar book.

This work is used as a text-book at several of our Agricultural Colleges, and justly enjoys a very high reputation. It is from the careful pen of R. Warington, F. C. S., who has won his reputation at Rothamsted estate, at the world famous private experiment station of Sir John B. Lawes, the greatest living benefactor of Agriculture. I know of no farm book that contains so much information in like space.

THE CHEMISTRY OF THE FARM.

BY

R. WARINGTON, F. C. S.

NEW YORK:
O. JUDD CO., DAVID W. JUDD, PRES'T,
751 BROADWAY.
1887.

PUBLISHERS' PREFACE.

This work is offered in the belief that it will meet the wants of many intelligent farmers, and others interested in the cultivation of the soil, who, while they have neither the time nor the inclination to take up Chemistry as a study, would gladly learn the present relations of Chemistry to Agriculture. The author of this book occupies an important position at Rothamsted. The most casual reader of agricultural journals is aware that this is the name of an old English estate to which the labors of Messrs. Lawes and Gilbert have given a world-wide reputation as a station where abundant means, added to the highest scientific ability, have been devoted to the elucidation of agricultural problems, solely for the benefit of agriculture. These labors are not for English agriculture especially, but have a world-wide application. The results which are freely given to the world, are those of experiments conducted in the field and stables, as well as in the laboratory, on a scale which gives them a practical value and commends them at once to the farmer as well as to the scientist.

While the author modestly refrains from even a suggestion to that effect, we regard his work as in accordance with the latest results attained at the center of agricultural investigation.

The visitor at Rothamsted is struck with the thoroughly practical character of everything about the place and the entire absence of anything like show.

We were, during a visit last year, especially interested with the exhibition of the constituents of a piece of English pasture, in which the different grasses and other plants, including weeds, were given, not only in figures, but in parcels containing the plants themselves in their proper proportions. The author, in his preface, expresses the hope that his work may be used for the teaching of agriculture in schools. In this we must disagree with him. If any work will answer for the use of public schools, no doubt this one will take the first rank.

The great obstacle to the use of this, or any similar work in schools, is the difficulty of finding teachers. Unless a teacher quite

understands and is thoroughly imbued with his subject, he can not profitably instruct others.

The author, in referring to the literature of the subject, mentions such works as will be found useful to the student. Among these are Prof. Johnson's "How Crops Grow" and "How Crops Feed." These volumes are standard works of reference, abroad as well as at home. In place of the European works upon plant life and plant growth which the author recommends to English readers, we may mention Gray's "First Lessons" as superior to any other work in the language as an elementary work in the study of plant life. No farmer, be he American or otherwise, can read this volume without receiving very much valuable information and suggestions which will prove of real practical value.

The language of the work is remarkably clear and concise, and avoids, so far as the subject will allow, the use of scientific technicalities.

As in England the term corn is used, especially for wheat, and generally for the small grains, while in this country it especially applies to Indian corn or maize, it has been thought advisable in an American Edition to change the word to accord with general usage. Where Indian corn is referred to in the work it is mentioned as maize, the name by which it is generally known in England.

The American reader should bear in mind the fact that the common or field bean of England is very different from the bean cultivated in this country. Garden forms of it, known as Windsor Bean, etc., are rarely tried by English gardeners in this country, but our hot summers make it very uncertain, and it is not known here as a field crop.

March, 1882.

THE CHEMISTRY OF THE FARM.

CHAPTER I.

PLANT GROWTH.

The Constituents of Plants.—Water—The conbustible elements of vegetable matter—The proportion of ash constituents in various parts of plants—The essential and non-essential elements of the ash—Composition of a crop of grass. *Function of the Leaves.*—Assimilation of carbon from the air—Formation of vegetable substance—Plant respiration—The transpiration of water. *Function of the Roots.*—Absorption of ash constituents and nitrogenous matter from the soil—The excretion of useless matter by the plant—The part played by ash constituents. *Germination.*—General character of seeds—The conditions and processes of their germination. *Plant Development.*—Annual plants—The order in which plant constituents are assimilated—Biennial and perennial plants—The storing up of food for a second season—Spring sap rich in sugar.

The first step towards a knowledge of plant chemistry must be an acquaintance with the materials of which plants are built up.

The Constituents of Plants.—The most abundant ingredient of a living plant is water. Many succulent vegetables, as turnips and lettuce, contain more than 90 per cent. of water. Timber felled in the driest time seldom contains less than 40 per cent. of water.

If a branch of a tree is burned the greater part is consumed and passes away in the form of gas, but there is left behind a small quantity of white ash. The same happens if any other part of a plant is burned. The constituents which form the dry matter of plants may be thus conveniently divided into two classes—the combustible and the incombustible.

The combustible part of plants is made up of five chemical elements—carbor, oxygen, hydrogen, nitrogen and sulphur; without these no plant is ever produced. Carbon generally forms about one-half of the dry combustible matter of plants. Nitrogen seldom exceeds 4 per cent. of the dry matter, and is generally present in much smaller amount. Sulphur is still smaller in quantity. The remainder is oxygen and hydrogen.

The carbon, hydrogen and oxygen form the cellulose, lignose, pectin, starch, sugar, fat, and vegetable acids which plants contain. The same elements united with nitrogen form the amides and alkaloids; and further united with sulphur the still more important albuminoids, which are essential constituents of all plants.

The incombustible or ash constituents form generally but a small part of the plant. The timber of freely-growing trees contains but 0.2—0.4 as ash constituents in 100 of dry matter. In seeds free from husk the ash is generally 2—5 per cent. In the straw of cereals 4—7 per cent. In farm roots 4½—8 per cent. In hay 5—9 per cent. It is in leaves, and especially old leaves, that the greatest proportion of ash is found; in the leaves of root crops the ash will amount to 10—25 per cent. of the dry matter.

The incombustible ash always contains five chemical elements—potassium, magnesium, calcium, iron and phosphorus, besides sulphur already mentioned. Iron is present in only very small quantity. These five elements, though forming a very small portion of the plant, are indispensable to its life. Besides the elements just named, an ash will generally contain sodium, silicon, and chlorine, with frequently manganese, and perhaps minute quantities of other elements. The supplementary elements just named are not apparently essential to plant life, though some of them discharge useful functions in the plant.

The metals above named occur in the plant as salts, being combined with phosphoric, nitric, sulphuric and various vegetable acids, of which oxalic, malic, tartaric and citric acid are the most common. The metals are also sometimes present as chlorides. Phosphorus occurs in the form of phosphates; silicon is present as silica. Sulphur occurs partly as sulphates and partly as a constituent of albuminoids. In the ash of plants the nitrates and the salts of the vegetable acids are found in the form of carbonates.

It is common to speak of the combustible ingredients of a plant as "organic," and the incombustible ingredients as "inorganic." This distinction is scarcely accurate, as those ash constituents which are indispensable parts of plants have, during the plant's life, as much right to be called "organic" as albumin or cellulose.

In the following table will be found the average composition of a crop of meadow grass weighing five tons when cut, and producing one and one-half ton of hay; this will illustrate what has just been said as to the constituents of plants. Further information as to the composition of crops will be found elsewhere.

COMPOSITION OF A CROP OF MEADOW GRASS.

Water			8,378 lbs.
Carbon	1,315	Combustible matter	2,613 lbs.
Hydrogen	144		
Nitrogen	49		
Oxygen and sulphur	1,105		
Potash	56.3	Ash	209 lbs.
Soda	11.9		
Lime	28.1		
Magnesia	10.1		
Oxide of iron	.9		
Phosphoric acid	12.7		
Sulphuric acid	10.8		
Chlorine	16.2		
Silica	57.5		
Sand, etc.	4.5		
Total crop			11,200 lbs.

Plants obtain the elements of which they are built up partly from the soil and partly from the atmosphere. From the soil they obtain, by means of their roots, all their ash constituents, all their sulphur and nearly the whole of their nitrogen and water. From the atmosphere they obtain, through the instrumentality of their leaves, the whole, or nearly the whole, of their carbon, with probably small quantities of nitrogen and water.

Function of the Leaves.—The source of vegetable carbon is the carbonic acid gas present in the atmosphere. Cabonic acid gas passes more readily through the cuticle of a plant than do the nitrogen and oxygen which make up the bulk of the atmosphere. The carbonic acid thus absorbed is decomposed within the chlorophyl cells of the plant under the influence of light, oxygen being evolved and the carbon retained by the plant. All green parts of a plant probably share in this action, but it is pre-eminently the function of the leaves. The decomposition of carbonic acid does not proceed in darkness, or at a very low temperature. The rays of light most active in effecting the decomposition are the yellow and orange rays; the blue, violet and dark red rays of the spectrum have scarcely any influence.

The oxygen gas given off by a green plant exposed to light is equal in volume to the carbonic acid decomposed, so that apparently the whole of the oxygen contained in the carbonic acid is returned to the atmosphere; the reaction is, however, really more complicated, as water is probably decomposed at the same time as the carbonic acid.

The exact nature of the reaction which takes place when carbonic acid is decomposed in the chlorophyl cells is still unknown. Starch, composed of carbon and the elements of water ($C_6H_{10}O_5$), is undoubt-

edly among the earliest products. Starch being an insoluble substance is converted into sugar (glucose) for the nourishment of distant parts of the plant, to which it is conveyed by the movement of the sap. In parts where growth is taking place, and new cells are being formed, the sugar of the sap is converted into cellulose, the substance which forms the cell walls, and of which the whole structure of the plant primarily consists. The conversion of starch into sugar and cellulose presents no chemical difficulties, as all these substances are the carbo-hydrates, that is they are composed of carbon and the elements of water.

The formation of albuminoids in the plant is not at present understood; we can only say that they are constituted out of the carbo-hydrates and some of the simple nitrogenous substances, most probably amides, present in the sap.

The vegetable acids in a plant are probably formed by oxidation; most likely by the oxidation of some of the carbo-hydrates.

The fatty matter of a plant may be formed from carbo-hydrates; or possibly from the splitting up of albuminoids.

We have just referred to oxidation as taking place in the plant. This is always going on in the interior during life, and as a result the plant is continually consuming a small quantity of oxygen, and giving out a small quantity of carbonic acid, an operation precisely similar to animal respiration. This action is not readily perceived during the day-time, being hidden by the opposite action of the chlorophyl cells, which absorb carbonic acid and evolve oxygen. If a plant is placed in darkness the respiratory action becomes manifest. The oxidation of matters already formed is an important means for the production of new bodies.

The decomposition of carbonic acid by green plants during daylight is of the utmost importance in maintaining an atmosphere suitable for the respiration of animals. An animal in breathing inspires atmospheric air; it expires air in which a part of the oxygen has been replaced by carbonic acid; the result of animal life is thus to accumulate carbonic acid in the atmosphere. Such accumulation would be injurious to health, but is prevented by the growth of plants. It has been calculated that an acre of forest producing annually 5,755 pounds of dry matter will consume the carbonic acid produced by the respiration of 15.4 men.

Besides carbonic acid, plants are apparently capable of absorbing a small quantity of ammonia through their leaves. The uncombined nitrogen of the atmosphere is not appropriated by plants. When rain

occurs after severe drouth water may be taken up to some extent through the leaf.

Plants which have no chlorophyl cells and possess, consequently, no green color, do not decompose carbonic acid. We have familiar examples of such plants in the broomrape and dodder of our clover fields, and in the common fungi. The broomrape and dodder are fed by the juïces of the plant on which they live as parasites. The fungi derive thei· carbon from the decayed vegetable matter in the soil.

Another important function of leaves consists in the transpiration of water. This transpiration takes place through small openings in the under side of the leaves, known as stomata, which have the property of closing in dry air and opening in moist. Transpiration takes place only in light; it will occur abundantly, even in an atmosphere saturated with water, if the plant be only exposed to sunshine. A small amount of general evaporation, distinct from transpiration proper, may occur in darkness. The amount of water evaporated from the surface of a growing plant is very large; land that has borne a crop is always much drier than a bare fallow.

The results of transpiration to the plant are most important, the evaporation of water from the leaves being a principal cause of the rise of the sap, and the consequent drawing up of water from the soil containing plant food in solution.

Function of the Roots.—The roots of a plant are the organs by which it absorbs water from the soil, and with this water a variety of food elements are introduced.

The roots take up apparently all the diffusable substances (those capable of passing through a membrane) which are present in the water which they draw from the soil. The plant may thus receive a number of substances not actually required for its nutrition.

The feeding power of roots is not, however, confined to the taking up of ready-formed solutions, they are also capable of attacking some of the solid ingredients of the soil, which they render soluble and then appropriate. This important action of the roots exists in different degrees with different plants. The action only takes place at the points of contact between the rootlets and the particles of the soil, and is brought about by the acid sap which the roots contain. This action of roots probably plays an important part in the supply of phosphoric acid and potash to the plant, as these substances, especially the former of them, exist in the soil in difficultly soluble forms, and are rarely found in solution in the water present in soils.

Besides furnishing the plant with its ash constituents, the root has the important function of supplying nitrogen; this is nearly always

taken up in the form of nitrates. A plant is capable of making use of nitrogen in the form of nitric acid or ammonia; it also, according to several experimenters, is able to assimilate nitrogen when in the form of urea, uric and hippuric acids, and several other amide bodies. The facility, however, with which ammonia and other nitrogenous substances, are converted into nitric acid in the soil is so great that nitrates become by far the most important source of nitrogen at a plant's disposal. Most plants are unable to assimilate the nitrogenous humus contained in soil.

The very weak solutions taken up by the roots are concentrated in the upper parts of the plant, the water being rapidly evaporated by the leaves, as already mentioned. The essential ash constituents are employed in the formation of new tissues. The non-essential ash constituents which have been taken up by the roots are partly disposed of in a solid form, as a permanent incrustation of the older tissues. The soluble salts which are not thus disposed of, at first accumulate in the sap, and are probably more or less removed from the surface of the leaves and stem by the washing effect of rain.

The deposition of silica upon the external tissues of wheat, barley and other graminaceous plants is a familiar example of the excretion of a non-essential ash constituent. Silica is also abundant in the old leaves, and in the outer bark of many trees, and is commonly found as an incrusting constituent of old tissues. Insoluble calcium salts, frequently the oxalate, are also deposited as incrusting matters in old tissues. These incrustations are indirectly of service to the plant, as they tend to harden the tissues and thus protect them from injury.

Soluble non-essential ash constituents, as chloride of sodium, are found abundantly in the succulent parts of plants when such ash constituents have been present in the soil. They generally diminish in quantity as the plant matures, and are never stored up in the seed.

The amount and composition of the ash of succulent plants, as meadow grass, clover, and mangel, is greatly influenced by the character of the soil, and the manure applied. The ash of a seed, on the other hand, is very constant in composition, resulting from the selective powers of the plant.

Of the particular action of the ash constituents within the plant little is known. Phosphoric acid and potash are undoubtedly the most important of the ash constituents; they are always found concentrated in those parts of the plant where cell growth is most active, as, for instance, in the layer (cambium) between the wood and bark of a tree, and are abundantly stored up in the seed.

Silica was long supposed to be an essential constituent of wheat,

barley, and other similar plants, and to be the ingredient on which the of ordinary farm crops and of the annual produce of three kinds of stiffness of their straw chiefly depended. It has been shown, however, that maize may be successfully grown without any supply of silica, and with no perceptible difference as to the stiffness of the stem. The grass growing on peat bogs contains scarcely any silica, though silica is abundant in ordinary hay.

Germination.—The seed is a storehouse of concentrated plant food, intended to nourish the germ until the root and leaf are developed. In the seeds of the cereals, and of many other plants, the chief ingredient is starch. Another class of seeds, of which linseed and mustard-seed are examples, contain no starch, but in its place a large quantity of fat. A seed generally contains a considerable amount of albuminoids; its ash is rich in phosphoric acid and potash.

For germination to take place, moisture, oxygen, a suitable temperature are necessary. Under these conditions the seed swells, oxygen is absorbed, a part of the carbonaceous ingredients is oxidized, heat is developed, and carbonic acid evolved. During these changes the solid ingredients of the seed gradually become soluble; the starch and fat are converted into sugar; the albuminoids are converted into amides—as for instance asparagine, probably also into peptones. With this supply of soluble food the radicle and plumule are nourished; they rapidly increase in size, emerge through the coats of the seed, and, if the external conditions are suitable, soon commence their separate functions as root and leaf. The process of germination may be easily studied in the ordinary operation of malting barley.

Seeds buried too deeply in the soil may not germinate for lack of oxygen. Or if germination takes place the plumule may fail to reach the surface, the store of food in the seed being exhausted before the layer of soil is penetrated, and daylight reached. The smaller the seed, the less, as a rule, should be the depth of earth with which it is covered.

Plant Development.—The development of the plant after germination follows a regular course. With an annual, which produces seed and dies during the first season, we have first a great development of root and leaf, which collect and prepare materials for growth; next comes the formation of a flower stem; and lastly, the production of flower and seed; after which the plant dies.

The materials furnished by the root preponderate in the young plant, but as the plant matures, the proportion of carbon compounds derived from the action of the leaves steadily increases. A cereal crop contains at the time of full bloom all the nitrogen and potash which

is found in the mature crop, the assimilation of phosphoric acid continues somewhat later; the increase of carbon and silica proceeds as long as the plant is in a green state.

When seed formation begins an exhaustion of the other parts of the plant sets in, starch, albuminoids, phosphoric acid and potash being transferred from the root, leaf, and stem, and stored up in the seed. If the season is a good one, and the development of the seed fully accomplished, the straw of the crop is left very thoroughly exhausted; while in a bad season it will retain far more of the materials acquired during growth. For the same reason straw cut while the crop is still green is far more nutritive than when perfect ripeness has been attained.

With a biennial or perennial crop the case is somewhat different. The first development of root and leaf is the same as in an annual; but towards the end of summer there is a storing up of concentrated plant food in the root or stem to serve for the commencement of growth in the following spring. In a biennial root crop, the turnip, for instance, the root attains a great size in autumn, the leaves dying after transferring to the root their most important constituents. The next season the root throws up a flower stem, and the store of matter accumulated during the preceding autumn is consumed in the production of seed. With the production of seed the root is exhausted and the plant dies.

In trees plant food is stored up at the end of summer in the pith, the pith rays, and in the layer between the wood and bark. The leaves which fall in autumn have lost nearly all their starch, albuminoids, phosphoric acid and potash, these having been transferred to the stem. By the action of the sun in springtime the new buds swell, the sap rises, the starch and other matters deposited in the wood during the previous autumn are re-dissolved, and employed at once for the production of new growths. The sugar found in maple sap during spring, results from the transformation of starch stored up in the preceding autumn.

CHAPTER II.

THE SOURCES OF PLANT FOOD.

The Atmosphere.—The carbonic acid, ammonia and nitric acid which it supplies—The quantity of combined nitrogen and chlorides contained in rain. *The soil.*—Its origin—Properties of sand, clay, calcareous matter and humus; their relation to water and heat—The plant food contained in soil, its quantity and condition—Losses by drainage—The absorptive power of soils—Influence of tillage, drainage and burning.

The Atmosphere.—We have already stated that the whole of the carbon of plants is obtained from the carbonic acid present in the atmosphere; 10,000 volumes of air contain about 3 1-2 volumes of carbonic acid, or about 1 lb. of carbon in 3,500 cubic yards of air. This small amount is made sufficient by the action of winds, which bring an enormous quantity of air in contact with both soil and plant.

The atmosphere also contains a very small and variable quantity of ammonia. Schlœsing found from 1 lb. in 6,000,000 cubic yards to 1 lb. in 119,000,000 cubic yards. The quantity is greatest, according to the same experimenter, in warm southerly winds. The ammonia of the air is directly absorbed by plants to a very small extent, it is rendered available chiefly through absorption by the soil, and by means of rain, which brings it in solution to the earth.

The atmosphere also furnishes a small amount of nitric acid. The nitrogen and oxygen of the atmosphere combine under the influence of electric discharges, nitrous acid being formed; this is converted into nitric acid by the action of ozone or peroxide of hydrogen. This formation of nitric acid in the atmosphere is the only original source of combined nitrogen on our globe, the existence of which has been placed beyond dispute. Nitric acid may also be formed in the atmosphere by the oxidation of ammonia by ozone and peroxide of hydrogen.

The total amount of nitrogen, in the form of ammonia and nitric acid, annually carried to the soil by rain, varies in different years and places. The average of many experiments on the continent gives 10.23 lbs. of nitrogen per acre. The average of two years' experiments at Rothamsted gave 7.29 lbs. The continental average is probably rather

above the truth for the open country, many of the determinations having been made near towns.

Rain also furnishes small quantities of alkaline chlorides, especially in the neighborhood of the sea; sulphates are also present. At Cirencester the chlorides in the rain are on an average equal to about 53 lbs. of common salt per acre per annum; at Rothamsted in Hertfordshire the quantity is about 22 lbs.

The soil.—All soils have been produced by the disintegration of rocks, generally through the prolonged action of water, air and frost. The character of a soil largely depends on the character of the rock from which it has been derived. Primitive and igneous rocks yield soils rich in potash; fossiliferous rocks produce soils rich in phosphoric acid. The principal ingredients of soils are sand, clay, carbonate of calcium and humus; as each of these preponderate the soil is said to be sandy, clayey, calcareous or peaty.

Sand is either composed of pure quartz (silica), or consists of fragments of more complex minerals—mica, for example. When the former is the case, the sand will supply no plant food; but in the latter case the gradual decomposition of the mineral will slowly increase the ash constituents available for the plant.

Clay is a silicate of aluminium, produced by the decomposition of felspar and other silicates; if absolutely pure it would furnish nothing to the plant; it always, however, contains some potash, and frequently a considerable quantity. Clay has the important property of absorbing retaining phosphoric acid, ammonia, potash, lime and other substances necessary for plant nutrition.

The calcareous matter of soils supplies lime to the plant; limestone also generally contains phosphoric acid. Carbonate of calcium is beneficial to the soil in many ways. It preserves the particles of clay in a separate coagulated condition, thus making heavy soils friable and pervious to water. It enables clay to exercise its absorbent power on various salts, which would otherwise escape its action. It also promotes the decomposition of vegetable matter, and the formation of nitrates in the soil. The presence of some salifiable base is essential for the performance of the chemical operations belonging to a fertile soil; the salifiable bases usually present are either carbonate of calcium or the alkalies derived from the decomposition of silicates.

The humus, or decayed vegetable matter of soils, has its origin in the dead roots, leaves, etc., of a previous vegetation. It is the principal nitrogenous ingredient of soils. A black soil, rich in humus, is sure to be also rich in nitrogen; a soil destitute of humus will contain

Contents of the Twentieth Annual Report of the Missouri State Board of Agriculture.

I. The Report of 508 pages is opened by the Secretary's remarks to the General Assembly, which includes a discussion of the relation of the "Grass Crop" to the fertility and wealth of the State, accompanied by a discussion of the conditions essential to the growth and harvesting of the grass crop.

II. This is followed by the "Business Proceedings" of the Board, including the expenditure of the State appropriation to the Agricultural College.

III. A report of the papers and discussions at the Farmers' Institute meetings for the winter as follows: This includes, a synopsis of a talk by G. W. Waters of Ralls county, on "Sheep Husbandry;" a paper on "Farm Homes" by A. S. Smith of Ralls county; a paper on "Apple Growing" by Charles Patterson of Adair county; one on "Vegetable Gardening" by Chas. Murtfeldt, Ex. Secretary of the Board; a talk by D. J. Bissell of Anamoosa, Iowa, on "Shallow Culture for Corn;" a paper on relation of "Grass to Soil Conservation" by H. J. Waters, B. A. S., assistant in the Secretary's office; a paper by A. Falcon of St. Clair county, on "Fall Plowing and Shallow Culture for Corn." Professor Taft of the Agricultural College has a paper on "Insects Injurious to Vegetation;" Levi Chubbuck, B. A. S., presents the "Farm Water Supply;" Dr. Paul Paquin, V. S. of the Agricultural College and State Veterinarian, gave a paper on "Breeding of Good, Paying, Healthy Stock.

IV. In addition to these papers given at Institute meetings, "Some Needed Changes," is discussed by M. B. W. Harmon, member of the Board from Nodaway county.

"WARRINGTON'S CHEMISTRY OF THE FARM."

A dollar book, one of the best treatises of 110 pages on Scientific Agriculture extant. Extract, inserted in full. The book is used as a text book in several of our Agricultural Colleges, but by arrangement with the publisher the Board is enabled to present it to 14,000 of our farmers.

"Practical Botany" is presented in a paper by Professor L. R. Taft.

Prof. Geo. D. Purinton, Botanist of the State Agricultural College, has a paper on "Scientific Agriculture and Horticulture."

"EXPERIMENT STATIONS REPORTS."

84 pages of extracts covering only practical questions and only the meat of the reports of the investigators is drawn from investigations for the past 10 years of this country and from Sir John B. Lawes.

Geo. H. Wallace, President of Missouri Wool Growers' Association, has an article on "Wool Examinations."

"Woman on the Farm" is presented in a paper by Mrs. G. E. Dugan of Sedalia.

"Bulletins 28, 29 and 30" of the Missouri Agricultural College follow, while the report of the competitors for the "Board's Corn Premium" of $175 completes the volume.

The Report can be secured by addressing J. W. Sanborn, Secretary, Columbia, Mo.

scarcely any nitrogen. The fertility of virgin soils is largely due to the nitrogenous humus which they contain.

Of all soil ingredients sand has the least, and humus the greatest capacity for retaining water. Light sandy soils thus suffer most from drouth, while applications of farm-yard manure, or the plowing in of green crops, increase the water-holding power of the soil by increasing the proportion of humus. The capillary power of soil, by which water is raised from the subsoil to the surface in dry weather, is least in open sandy soils composed of coarse particles, and greatest in the case of loam or clay.

Dark-colored soils absorb the greatest amount of heat from the sun's rays, and light-colored soils least. The presence of humus is thus favorable to soil warmth. Quartz sand is an excellent conductor of heat; chalk is a bad conductor. A soil rich in sand will thus be warmed or cooled more rapidly, and to a greater depth than a soil containing but little sand. Water has a very considerable effect in cooling a soil, partly from its high specific heat, and partly from the immense consumption of heat during its evaporation. A wet soil is always colder then a dry one. The drainage of wet land will thus result in a greater warmth of the surface soil, and consequently an earlier growth in spring.

The proportion of plant food present in soils is very small, even when the soil is extremely fertile. The surface soil (first 9 inches) of a pasture may contain when dry 0.25 of nitrogen per cent., while soil of the same depth from a good arable field may yield 0.15 per cent., and a clay sub-soil 0.05 per cent. A good surface soil may contain 0.20 per cent. of phosphoric acid, or not unfrequently a smaller quantity. Potash varies much, rising to 1.0 per cent. or more in some clay soils, but being generally much smaller.

The weight of soil on an acre of land is, however, so enormous, that small proportions of plant food may amount to very considerable quantities. Nine inches' depth of arable soil (clay or loam) will weigh, when perfectly dry, about 3,000,000 or 3,500,000 lbs. A pasture soil will be lighter, the first 9 inches weighing when dried and the roots removed about 2,250,000 lbs. Supposing, therefore, a dry soil to contain 0.10 per cent. of nitrogen, phosphoric acid, or potash, the quantity in 9 inches of soil will be from 2,250 lbs. to 3,500 lbs. per acre.

A large part of the elements of plant food contained in soils is present in such condition that plants are unable to make use of it. A soil may contain many thousand pounds of phosphoric acid or of nitro-

gen, and yet be in a poor condition ; while a small dressing of readily available food, as superphosphate or nitrate of sodium, may greatly increase the fertility.

The nitrogen contained in humus is not in a condition to serve as a general plant food ; cereal crops are apparently unable to appropriate it ; leguminous crops, however, possibly assimilate some humic matters. By the action of a minute *Bacterium* present in all soils, humus and ammonia are oxidized, and their nitrogen converted into nitric acid. Nitrification only takes place in moist soil, sufficiently porous to admit air. It is also necessary that some base should be present with which the nitric acid may combine ; this condition is usually fulfilled by the presence of carbonate of calcium. Nitrification is most active at summer temperatures ; it ceases apparently near the freezing point.

The fragments of rock present in soil, as stones, gravel, and sand, are as a rule, of little value to a plant, the elements of plant food which they contain being in too insoluble a condition to be attacked by the roots. These fragments of rock may, however, be slowly decomposed by the mechanical action of frost, and by the chemical action of water, and their contents thus gradually made available to the plant. The solvent power of the water in a soil is greatly increased by the carbonic acid, and perhaps also by the humic acid it holds in solution. Water containing carbonate of calcium in solution is especially capable of attacking silicates.

If water is allowed to drain through a soil it carries with it a part of the readily soluble matter which a soil contains. The substances chiefly removed by the water will be the nitrates, chlorides, and sulphates of calcium and sodium. When heavy rain falls these substances are washed into the subsoil, and partly escape by the nearest outfall into the springs, brooks and rivers. The loss of nitrates from highly manured land during a wet season is very considerable. When dry weather sets in evaporation takes place at the surface of the soil, the water of the subsoil is slowly brought again to the surface by capillary attraction, and the salts it contains are concentrated once more in the upper soil, forming in some rare instances a white crust of salt upon the surface. Capillary attraction has little influence in the case of sandy soils.

Of these readily soluble salts the nitrates are of the greatest importance to plant food. The quantity of nitrates in a surface soil will vary greatly, depending on the richness of the soil in nitrogen, the previous conditions as to temperature and moisture, the extent of recent washing by rain, and on whether the soil is or is not under crop.

Where a crop is growing the nitrates will be kept nearer the surface, the evaporation of water from a growing crop being far greater than from a bare soil. The nitrates will also be constantly taken up by the roots, and employed as plant food. The loss of nitrates by drainage is thus far less when the land is under crop than in the case of a bare fallow.

Phosphoric acid, potash, and ammonia are very rarely found in drainage water. If a solution containing phosphoric acid, potash, or ammonia is poured on a sufficiently large quantity of fertile soil, the water which filters through will be found destitute of these substances. This retentive power of soil for phosphoric acid, potash, etc., is of the utmost importance in agriculture. The action is a complex one. All salts are doubtless retained to some extent by soil through mere mechanical adhesion; salts, thus feebly retained, as nitrates and chlorides, can be easily removed by washing with water. Other substances are, on the contrary, retained by chemical affinity; these are not removed by washing, or but to a small extent. The ingredients of the soil which exercise a chemical retentive power are the hydrates of ferric oxide and alumina, the hydrous silicates of aluminium, and humus.

Ferric oxide is a common ingredient of soils; to it the red color of many soils is owing. To the presence of ferric oxide the retention of phosphoric acid is chiefly due, an insoluble basic phosphate of iron being produced. Alumina acts in the same manner; Ferric oxide and alumina have also a retentive power for ammonia and potash, but the compounds formed are more or less decomposed by water. To the hydrous silicates the permanent retention of potash and other bases is probably chiefly due. Humus has a great absorbent power for ammonia. Other bases, as magnesia and lime, are also retained by soil, but in a less powerful manner than are potash and ammonia.

Soils destitute of carbonate of calcium take up very little potash or ammonia when these are applied as salts of powerful acids, as for instance, the chlorides, nitrates and sulphates. When carbonate of calcium is present the potassium or ammonium salt is decomposed, the base is retained by the soil, while the acid escapes into the drainage-water united with calcium. The addition of carbonate of calcium may thus greatly increase the retentive power of a soil for bases.

The fertility of a soil is nearly connected with its power of retaining plant food. Sandy soils, from their small chemical retentive power, and free drainage, are of small natural fertility, and dependent on immediate supplies of manure.

There can be little doubt that the plant food contained in soil which is capable of being taken up by the roots, exists either in solution, or in the states of combination just referred to—that is in union with ferric oxide, hydrous silicates, and humus. Different crops have very different powers of attacking these various forms of plant food.

The operations of tillage and drainage serve in several ways to increase the amount of plant food which is at the disposal of a crop.

By tillage the surface soil is kept in an open porous condition, favorable for the distribution of roots. By this means also capillary attraction is diminished, and the land consequently suffers less from drouth; the water-holding power of the surface soil is also increased. A more important result of tillage is that the soil is thoroughly exposed to the influence of the air. Soils containing humus or clay will absorb ammonia from the atmosphere, and thus increase their store of nitrogen. The organic remains of former crops and manuring are also oxidized, the nitrogen being converted into nitric acid. The rocky fragments which a solid contains, as fragments of silicates or limestone, will at the same time be more or less disintegrated by the combined action of water and air, assisted by the carbonic and humic acids arising from the oxidation of vegetable matter, and a portion of the insoluble plant food be thus brought into a state suited for assimilation by the roots of crops. In winter time the disintegration of the various ingredients of the soil is greatly assisted by frost. Water in freezing expands, and thus rends asunder the substance frozen. Of the various results brought about by tillage, the increased production of nitrates must be ranked among the most important.

By drainage the various chemical actions we have just mentioned are carried down to a greater or less extent into the subsoil, for as the water level is lowered the air enters from above to fill the cavities in the soil. By drainage also the depth to which roots will penetrate is increased, for roots will not grow in the absence of oxygen, and rot as soon as they reach a permanent water level. In a water-logged soil deoxidation is active, the nitrates present are destroyed, a part of the nitrogen being envolved as gas; the soil may thus suffer a considerable loss of plant food.

Burning is occasionally resorted to as a means of increasing the available plant food, and improving the texture of a heavy soil. The soil is burned in heaps, which are then spread over the land. If the soil contains limestone it is easy to see that the phosphates of the limestone may become more available by the complete disintegration which attends the conversion into lime. The lime will also attack the sili-

cates of the soil at a high temperature, and liberate a part of the potash from its insoluble combinations. To produce the best results it is essential that the burning should take place at a low temperature. This treatment by burning is a very extreme one, and can be recommended only in a few cases; it must always be attended with an entire loss of the nitrogen in the soil burned. The plowing in of burned clay is of use in improving the texture of heavy land.

CHAPTER III.

MANURES.

Difference between natural vegetation and agriculture—necessity for manuring. *Farm-yard Manure.*—Circumstances which influence its character; its average composition; slowness of its effect—Seaweed similar to farm-yard manure—*Guano—Sulphate of Ammonium—Nitrate of Sodium—Soot, Dried Blood and Woolen Refuse—Bones—Ground Phosphates—Superphosphate—Gypsum—Lime, Chalk and Marl—Potassium Salts—Common Salt—Application of Manure*—Importance of thorough distribution—Best time for application—The return made by the crop.

In the natural vegetation of a forest or prairie the soil suffers no diminution of plant food. The elements taken from the soil are returned to it on the decay of the plants which the soil has nourished, or on the death of the animals which have fed on these plants. Under these circumstances the surface soil becomes rich in carbon and nitrogen, the quantity contributed by the atmosphere exceeding all losses. The surface soil also becomes rich in the ash constituents of plants, these being collected from the subsoil by the roots and left at the surface on the decay of the plant. A virgin soil thus generally contains an abundance of plant food, and will produce large crops without manure.

In human agriculture, on the other hand, both vegetable and animal produce are consumed off the land that has reared them. Provision must therefore be made, sooner or later, to return to the land a part at least of the plant food removed from it, if permanent fertility is to be maintained. Hence the necessity for manuring.

The most complete return to the land would be accomplished by manuring it with excrements of the men and animals consuming the crops. This is partially done by the application of barn-yard manure; but the congregation of men in cities, and the difficulty of employing sewage with profit, prevent this plan being thoroughly carried out. The farmer is thus generally obliged to purchase manures for the land in exchange for the crops and stock sold off it.

On very poor soils it is necessary to make a very complete return of all the elements of plant food removed by the crops, but in most soils there is an abundance of some one or more of these elements, and

a partial manuring will consequently suffice. With high farming the contributions to the soil may be in excess of the exports, and the land consequently increase in fertility. The nature of the exhaustion resulting from the growth of particular crops, and the economic application of manure to meet their special requirements, will be considered in Chapter IV. The losses which a farm sustains by the sale of animal products will be treated of in the section on "The Constituents of Animals."

Farm-yard Manure consists of the liquid and solid excrements of the farm stock, plus the straw employed as litter. Its composition will vary according to the character of the animals contributing to it, the quality of their food, and the nature and proportion of the litter. The composition of the manure will also depend a good deal upon the method in which it has been prepared.

In the case of an adult animal, neither gaining nor losing weight—a working horse for instance—the excrements will contain the same quantity of nitrogen and ash constituents as was present in the food consumed. If, however, the animal is increasing in size, is producing young, or furnishing milk or wool, the nitrogen and ash constituents in the excrements will be less than those contained in the food, the difference appearing as animal increase. The manure from animals of this class will therefore be poorer than that obtained from the former class, supposing the same food given to each. We must not expect valuable manure from a cow in full milk, or from a rapidly growing pig.

The character of the food will affect the quality of the manure even more than the character of the animal. A diet of maize and straw chaff can yield only a poor manure, because these foods contain a very little nitrogen or phosphates. A diet including a liberal amount of oil-cake or beans will, on the other hand, yield a valuable manure, these foods being rich in nitrogen and ash constituents. A common mode of increasing the supply of manure on a farm is by the consumption of purchased food by the stock. This part of the subject will be more fully discussed in Chapter IX.

The treatment of the manure is also most important. A large proportion of the nitrogen is voided in the form or urine, and generally the richer the diet the higher will this proportion be. If, therefore, the manure is washed by rain, and the washings are allowed to drain away, serious loss will occur. Hence the superiority of box manure to that made in an open yard.

It must also be recollected that the urea, which forms the chief nitrogenous ingredient of urine, is speedily changed by fermentation into corbonate of ammonium; as this is a volatile substance, a loss of

a part of the nitrogen may easily occur, especially if an insufficient amount of litter is employed.

Farm-yard manure rapidly undergoes fermentation. If placed in a heap the mass gets sensibly hot, and a large quantity of carbonic acid is given off. When the fermentation occurs in a place protected from rain, carbonaceous matter is destroyed, but little loss of nitrogen takes place. Rotten manure, when well made, is more concentrated than the fresh, having diminished in weight during fermentation, with but little loss of valuable constituents. Some of the constituents have also become more soluble.

Farm-yard manure will contain from 65 to 80 per cent. of water. The nitrogen may be 0.40 to 0.65 per cent., or higher, it produced by highly fed animals. The ash constituents will be 2.5 to 3.0 per cent., exclusive of the sand and earth always present. Of these ash constituents 0.4 to 0.7 will be potash; and 0.2 to 0 4 phosphoric acid. One ton of farm-yard manure will thus supply 9—15 pounds of nitrogen, a similar amount of potash, and 4—9 pounds of phosphoric acid.

Farm-yard manure is a "general" manure; that is it supplies all the essential elements of plant food. The immediate return from an application of farm-yard manure is much less than from the same amount of plant food applied in artificial manures. The effect of farm-yard manure is spread over a considerable number of years, its nitrogen being chiefly present not as ammonia, but in the form of carbonaceous compounds, which decompose but slowly in the soil.

Seaweed when fresh is, on the whole, similar in value to farm-yard manure. It becomes more valuable as it loses water.

Guano.—This manure consists chiefly of the dried excrements of sea fowl. When guano has been deposited in the absence of rain it contains a large amount both of nitrogenous matter and phosphates. If exposed to rain the original nitrogenous matter is decomposed, and the nitrogen volatilized in the form of carbonate of ammonium; the guano remaining is then almost purely phosphatic. Ichaboe guano, for example, is a recent deposit, containing about 12 per cent. of nitrogen, and 12 per cent. of phosphoric acid; while Mejillones guano is a phosphatic guano, containing 0.9 per cent. of nitrogen, and 32.5 per cent. of phosphoric acid. From its great variation in composition guano should always be purchased on analysis.

In a nitrogenous guano the nitrogen is chiefly present as uric acid, and as ammonium salts. The strong smell of a damp guano is due to carbonate of ammonium. The phosphoric acid exists principally in the form of phosphate of calcium, but in nitrogenous guanos

a small part exists as phosphate of ammonium, a salt readily soluble in water. Guano which has not suffered by washing may contain 3 to 4 per cent. of potash.

Nitrogenous guano is a highly concentrated manure, and may be employed with excellent effect for grain crops, potatoes and roots. Phosphatic guanos may be employed for turnips, but such guanos are more usually converted into superphosphate before they are applied to the land.

Sulphate of Ammonium.—This substance is prepared from the ammoniacal products of gas works; in its crystallized form it is the most highly nitrogenous of all the manures at a farmer's disposal, containing about 20 per cent. of nitrogen.

It should be ascertained in every case that the manure is free from sulphocyanate of ammonium, as this substance is very injurious to plants. If sulphocyanates are present a solution of the salt will become blood-red on the addition of ferric chloride.

Sulphate of ammonium is a "special" manure, valuable solely for its nitrogen. It is a powerful manure for grain crops, for which it is best employed in conjunction with superphosphate.

Nitrate of Sodium.—An enormous deposit of the crude salt, containing much chloride of sodium, is found in Peru. The nitrate sent to this country has been purified by crystallization; it will contain about 15.6 per cent. of nitrogen. The most usual impurity is common salt.

This manure, like the preceding, is valuable solely for its nitrogen. It is an excellent manure for all crops requiring artificial supplies of nitrogen, especially grain crops and mangels. For grain crops it is best employed together with superphosphate. Nitrate of sodium should not be mixed with a damp superphosphate, else nitric acid may be lost. It is best to mix the two immediately before use; or the superphosphate may be sown with the grain, and the nitrate applied afterwards as a top-dressing.

Nitrate of sodium is especially suited for clay land. It is quicker in its action than any other nitrogenous manure, and is therefore the best manure to employ when a late dressing has to be given.

Soot, Dried Blood, and Woolen Refuse are all purely nitrogenous manures. Soot owes its value to the presence of a small and variable quantity of ammonium salts. Dried blood is an excellent manure, containing 10 to 13 per cent. of nitrogen. Shoddy, and other forms of wool and hair are very variable in composition, owing to the admixture

of dirt, grease and other foreign matter; the nitrogen they contain will range from about 5 to 10 per cent.

The nitrogen of blood, wool and hair, is not in a form suitable as plant food. Blood readily decomposes in the soil, yielding ammonia and nitric acid. Wool and hair decompose much more slowly, and their effect is spread over many years.

Soot is generally employed as a top-dressing for spring grain. Dried blood is an excellent manure for wheat. Wool and hair are chiefly used for hops.

Bones.—These are largely employed as manure; the fat is usually first extracted by steaming. Commercial bones contain about 3.6 per cent. of nitrogen, and 23 per cent. of phosphoric acid, existing as phosphate of calcium. Bones that have been boiled to extract the gelatine contain much less nitrogen, but a larger proportion of phosphates.

Bones decompose but slowly in the soil, especially on heavy land; their effect is thus spread over several years. The finer the bones have been ground the more immediate is their effect. Bones are usually employed for pasture and for turnips.

Ground Phosphates.—Some phosphates when finely ground may, on certain soils, be successfully employed as manure without previous conversion into superphosphate. The phosphates most suitable for this purpose are phosphatic guanos, bone-ash and South Carolina phosphate. The soils most suitable for such manures are those rich in humus and poor in carbonate of calcium; these being the conditions (presence of humic and free carbonic acid) most favorable to the solution of phosphate of calcium. Pasture soils are especially suitable for such treatment. The solution of the ground phosphate may be facilitated by forming it into a compost with farm-yard manure before its application, or by employing with it sulphate of ammonia. The phosphate should be employed in very fine powder.

Superphosphate.—An abundance of mineral phosphates (phosphates of calcium) occur in nature; many of these are so little soluble that their effect as manure is but small; by treating them with sulphuric acid the sparingly soluble tricalcic phosphate is converted into the readily soluble monocalcic phosphate, sulphate of calcium being at the same time produced. Superphosphate is thus a mixture of monocalcic phosphate, and generally some free phosphoric acid with gypsum, and various impurities (as sand and compounds of iron and aluminium), derived from the original mineral. A superphosphate will always contain more or less of undissolved phosphate; this amount will be more

considerable if the manure is badly made, or if the original mineral contained much ferric oxide or alumina.

The value of superphosphate chiefly depends on the percentage of "soluble phosphate" present. By this term analysts do not mean monocalcic phosphate, but the quantity of tricalcic phosphate rendered soluble.

In England there is an excellent deposit in the Cambridge coprolite. This is largely used for making superphosphate. Other coprolites are also employed, but they are less suitable. Immense quantities of mineral phosphates are imported principally from South Carolina, Spain, Bordeaux and Canada, besides considerable quantities of phosphatic guano.

The superphosphates richest in soluble phosphate (40 to 45 per cent.) are prepared from phosphatic guanos. Bone, ash, and some phosphorites, also yield high quality manures. The great bulk of our superphosphates is at present prepared from Carolina phosphate or coprolite; such manure will contain 23 to 27 per cent. of soluble phosphate.

Superphosphates form the basis of almost all manufactured manures. By using bones, or by adding shoddy or crude ammonium salts, turnip manures are produced containing a small amount of nitrogen. By mixing with the superphosphate a larger amount of ammonium salts, or nitrate of sodium, the articles sold as grain, grass, mangel and potato manures are prepared. Superphosphate made largely from bones is known as dissolved bones.

When superphosphate is applied to a soil containing carbonate of calcium, the soluble phosphate is speedily precipitated, but in a form easily taken up by the roots of plants. In most cases the phosphoric acid is finally converted into basic phosphate of iron, a substance attacked with difficulty by plants.

Superphosphates are naturally more speedy in their effect than manures consisting of undissolved phosphate. A small quantity of phosphoric acid applied as superphosphate will have as great an effect as a considerable quantity applied as bones or ground phosphate.

Superphosphate is chiefly employed for turnips, for which it is invaluable; it is also of considerable use for grain crops, especially barley. Its use tends to early maturity in the crop.

Gypsum.—This manure is one of limited value. It is composed of calcium and sulphuric acid, and is most suitable for crops, such as clover and turnips, which require a considerable amount of sulphur. As superphosphate always contains much gypsum, special applications of gypsum will be unnecessary where superphosphate is employed.

Lime, Chalk and Marl, are frequently manures of the greatest importance. On soils naturally destitute of lime, as is the case with many clays and sandstones, these manures will supply an indispensable element of plant food. Some marls will also supply a notable quantity of phosphoric acid. In most cases, however, the beneficial influence of these manures is due to the chemical actions which lime performs in the soil; the chief of these have been already glanced at under the head of "Soil."

Burned lime is much more powerful in its action on vegetable matter than calk or marl; it should be used with discrimination, lest the humus of the soil be unduly diminished. Heavy clays, or soils rich in humus, are those most benefited by burned lime. In reclaiming peat bogs lime is of the highest value. The acid humic matter of the peat is neutralized by the lime, and the nitrogen held in combination is converted into ammonia and nitric acid, and thus made available to a crop.

The general effect of lime is to render available the plant food already in the soil, without itself supplying any significant amount; liming cannot, therefore, be successfully repeated except at considerable intervals.

Potassium Salts.—These salts are now obtained from Stassfurt and Leopoldshall in large quantities; they form a thick deposit overlying an enormous mass of rock salt. The commonest potassium salt employed as manure is kainit; it consists of chloride of potassium, sulphate of magnesium and water, with frequently chloride of magnesium and common salt in addition. Kainit will contain 13 to 14 per cent. of potash. Calcined kainit contains less water, and some magnesia in place of the chloride of magnesium; it will contain 15 to 17 per cent. of potash.

Wood ashes may also be employed as a potash manure; they will contain between 5 and 15 per cent. of potash. The ash of young boughs is richer than that from full-sized timber.

Potash manures produce their greatest effect on pasture; clover and turnips may also be benefited by their use. Many soils are naturally well furnished with potash; on these soils potash manures are almost without effect.

Common Salt.—Chloride of sodium supplies no essential ingredient of plant food. The little value which salt possesses as a manure is probably due to its action in the soil, where it may help to set free more important constituents.

Application of Manures.—A manure can be efficacious only when its contituents are brought into contact with the roots of the crop. To

obtain this contact to the fullest extent the manure must be thoroughly and evenly distributed throughout the depth of soil mainly occupied by the roots. Soluble manures—as nitrate of sodium, chloride of sodium, ammonium salts, potassium salts and superphosphate—have the great advantage that they distribute themselves within the soil after the first heavy shower far more perfectly than can be done by any mode of sowing. When manure is especially required by the plant in its earliest stages—as superphosphate for turnips—it may be drilled with the seed; but, as a rule, manure should be sown broadcast, and plowed in or harrowed.

Top-dressing, that is sowing manure on the surface of land already under crop, should generally be confined to manures that are soluble, or the principal constituents of which easily become soluble in the soil. Nitrate of sodium is sown with advantage in this manner if showery weather can be depended on to distribute the manure in the soil. On pasture all manures are necessarily applied as top-dressings.

Whenever possible, manure should be reduced to a fine powder before application. Artificial manures, if distributed by hand, should first be made up to a considerable bulk by mixing with fine dry soil or ashes. Manures containing ammonia must not be mixed with alkaline ashes, else some of the ammonia will be lost.

Manures of little solubility, or those of which the soil has a great retentive power, may be applied to the land some time before the growing period of the crop. Diffusible manures, on the other hand, should be applied only when the crop is ready to make use of them, else serious loss may occur from drainage. Farm-yard manure, rape cake and bones, and to some extent superphosphate and potassium salts, belong to the former class; while nitrates and all manures containing ammonia, belong to the latter class. It was formerly supposed that the great retentive power of fertile soils for ammonia would effectually prevent any loss by drainage; we now know that ammonia is speedily converted into nitrates after mixing with the soil, and that these nitrates are readily washed out by heavy rain.

Following these principles, an autumn manuring for what may consist of farm-yard manure, blood or shoddy, with or without superphosphate; but dressings of guano, ammonium salts, or nitrate of sodium should be deferred until the spring. The question is, however, clearly one of climate, and with a dry winter climate ammonium salts or guano may de applied with advantage in the autumn.

On soils of open texture, and little retentive power, preference must often be given to manures of little solubility, in order to diminish

the loss occasioned by heavy rain. Bulky organic manures, as farm-yard manure or seaweed, are in such cases very suitable.

No dressing of manure is completely taken up by the crop to which it is applied, dressings larger than the actual requirements of the crop must therefore be applied to obtain a given result. Soluble and active manures produce their principal effect at once, and are of little benefit to subsequent crops. Sparingly soluble manures, and those which must suffer decomposition in the soil before they are of service to the plant, as farm-yard manure and bone, will on the contrary continue to produce an effect over many years. Farmers have a prejudice in favor of the latter class of manures, but it is clear that the quickest return for capital invested is afforded by the former class.

Nitrogen applied as ammonium salts or nitrates will give all its effect during the first year; 45 to 50 per cent. of the nitrogen applied in this form to wheat and barley is according to Lawes and Gilbert, recovered on an average in the increase. In the case of farm-yard manure, applied on the heavy land at Rothamsted to wheat and barley, only about 10 to 15 per cent. of the nitrogen was recovered in the increase, but the effect on the barley continued many years after the application of the manure ceased. It is evident that a small quantity of an active manure will accomplish the same work as a large quantity of one less active.

The residues of phosphatic and potassic manures are available for subsequent crops, but are distinctly less active than fresh applications of the same manures.

CHAPTER IV.

CROPS.

The dry matter, nitrogen, and ash constituents, in average crops. *Cereal Crops.*—Characteristic composition—Mode of feeding—Most suitable manuring. *Meadow Hay.*—Characteristic composition—Demand for ash constituents—Influence of manures on quantity and quality—Pastures especially suited for obtaining nitrogen from the atmosphere. *Luguminous Crops.*—Characteristic composition—Source of nitrogen obscure—Clover sickness. *Root Crops.*—Characteristic composition—Differences in the nutrition of turnips, mangels, and potatoes. *Forest Growth.*—Large production of dry matter for small consumption of ash constituents and nitrogen. *Adaptation of Manures to Crops.*—The feeding power of each crop must be taken into account—Economic distribution of manure in a rotation—The practical value of manures only known by experiments on each farm. *Influence of Climate and Season.*

To understand the chemistry of crops we must first inquire as to their composition. The following table gives the average composition of ordinary farm crops and of the annual produce of three kinds of forest. The quantities of carbon, hydrogen, and oxygen present are omitted, also some of the smaller ash constituents. By "pure ash" is understood the ash minus sand, charcoal, and carbonic acid.

The composition of grain, and of all seeds, is tolerably constant; but the composition of straw, leaves, roots, and tubers, will vary very considerably according to the character of the soil, manure, and season.

THE WEIGHT AND AVERAGE COMPOSITION OF ORDINARY CROPS IN POUNDS PER ACRE.

(The long ton, 2,240 pounds, is used in this calculation.)

	Weight of crop.		Total pure ash.....	Nitrogen.	Sulphur..	Potash...	Soda.....	Lime.....	Magnesia	Phosphoric Acid.	Chlorine.	Silica.....
	At Harvest.	Dry.										
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Wheat, grain, 30 bushels	1,800	1,530	31	33	2.7	9.7	0.9	1.0	3.7	14.3	0.2	0.5
" straw	3,158	2,653	158	12	5.1	18.2	2.5	9.2	4.0	8.4	1.7	110.6
Total crop	4,958	4,183	189	45	7.8	27.9	3.4	10.2	7.7	22.7	1.9	111.1
Barley, grain, 40 bushels	2,080	1,747	46	35	2.9	9 8	1.0	1.3	4 0	16.2	0.4	12.0
" straw	2,447	2,080	100	12	3.3	21.6	4.2	8.5	2.5	4.4	3.2	51.5
Total crop	4,527	3,827	146	47	6.1	31.4	5.2	9.8	6.5	20.6	3 6	63.5
Oats, grain, 45 bushels	1,890	1,625	54	38	3.2	8.5	1.4	2.0	3.9	11.8	.....	24.8
" straw	2,835	2,353	140	14	4.8	29.6	5.9	9.8	5.3	7.1	5.5	69.3
Total crop	4,725	3,978	194	52	8.0	38.1	7.3	11.8	9.2	18.9	5.5	94.1
Meadow hay, 1½ ton	3,360	2,822	208	49	5.7	56.3	11.9	28.1	10.1	12.7	16.2	57.5
Red clover hay, 2 tons	4,480	3,763	255	102	9.4	87.4	4.1	86.1	30.9	25.1	9.4	6.8
Beans, grain, 30 bushels*	1,920	1,613	57	77	4.4	23 0	0.8	2.9	3.8	22.3	1.5	0.8
" straw "	2,240	1,848	130	22	4.9	58.1	4.9	30.2	10.3	9.2	18.1	6.9
Total crop	4,160	3,461	187	99	9.3	81.1	5.7	33.1	14.1	31.5	19.6	7.7

Turnips, roots, 17 tons	38,080	3,126	218	71	15.2	108.6	17.0	26.5	5.7	22.4	10 9	2.6
" leaf, "	11,424	1,531	146	49	5.7	40.2	7.5	48.5	3.8	10.7	11.2	5.1
Total crop	49,504	4,657	364	120	20.9	148.8	24.5	74.0	9.5	33.1	22.1	7.7
Swedes, root, 14 tons	31,360	3,349	163	74	14.6	63.3	22.8	19.7	6.8	16.9	6.8	3.1
" leaf, "	4,704	706	75	28	3.2	16,4	9.2	22.7	2.4	4.8	8.3	3.6
Total crop	36,064	4,055	238	102	17.8†	79.7	32.0	42.4	9.2	21.7	15.1	6.7
Mangels, root 22 tons	49,280	5,628	410	96	4.9	191.1	75.4	24.2	19.7	34.0	40 6	16.4
" leaf, "	18,233	1,654	280	51	9.1	71.4	65.2	29.1	27.2	15.1	49.8	9.2
Total crop	67,513	7,282	690	147	14.0	262 5	140.6	53.3	46.9	49.1	90.4	25.6
Potatoes, tubers, 6 tons	13,440	3,360	126	47	2.7	75.4	2.0	2.9	5.7	24.1	3.5	2.9
" haulm †	4,274	954	50	20	2.1	1.1	2.0	22.7	12.4	2.7	1.9	2.1
Total crop	17,714	4,314	176	67	4.8	76.5	4.0	25.6	18.1	26.8	5.4	5.0
Beech, wood	.....	2,822	26	.....	.....	4.2	0.8	12.9	3.4	2.6	.....	2.2
" leaf litter	.....	2,975	166	.....	.....	8.8	1.6	73.1	10 9	9.3	.....	53.9
Total produce	.....	5,797	192	.....	.....	13.0	2.4	86.0	14.3	11.9	.....	56.1
Spruce Fir, wood	.....	3,064	20	.....	.....	3.6	0.4	8.2	1.8	1.3	.....	2.9
" leaf litter	.....	2,683	121	.....	.....	4.3	1.5	54.4	6.2	5.7	.....	44.3
Total produce	.....	5,747	141	.....	.....	7.9	1.9	62.6	8.0	7 0	.....	47 2
Scotch Pine, wood	.....	2,834	15	.....	.....	2.3	0.2	9.0	1.5	1.0	.....	0.5
" leaf litter	.....	2,845	42	.....	.....	4.3	1.7	16.8	4 3	3.3	.....	5.8
Total produce	.....	5,729	57	.....	.....	6.6	1.9	25.8	5.8	4.3	.....	6.3

* The English Field Bean (*Vicia*) scarcely known in this country as a field crop. † Calculated from a single analysis only.

Cereal Crops.—These contain much less nitrogen than either the leguminous or root crops; about three-quarters of the nitrogen is in the grain, and only one-quarter in the straw. The amount of phosphoric acid is not very different from that found in other crops; this ingredient is, in fact, the most constant of all the constituents of crops; it is chiefly concentrated in the grain. Potash and lime are present in much smaller quantity than in other crops; they are chiefly concentrated in the straw.

The presence of a large amount of silica is characteristic of the cereal crops; they possess apparently a capacity for feeding on silicates not enjoyed by other crops. The base of the silicate is made use of by the plant, while the silica itself is excreted upon the surface of the leaves and straw. It has been shown that silica is by no means essential for the growth of cereals; they take it up freely, but can also do without it.

The autumn sown cereals (wheat and rye) have both deeper roots, and a longer period of growth, than the spring sown cereals, and are better able than the latter to supply themselves with the necessary ash constituents from the soil. Barley possesses a considerable development of root near the surface, and is apparently more capable of obtaining nitrogen from the soil than wheat.

Cereal crops derive their nitrogen almost exclusively from nitrates; the form in which the great bulk of the nitrogen is present in the soil is unsuitable for them. Notwithstanding, therefore, the small amount of nitrogen contained in cereal crops, they rank among those most benefited by nitrogenous manures. Phosphates, though of little use by themselves, are also beneficial (especially in the case of spring crops) when applied with nitrogenous manure. A nitrogenous guano, or an application of nitrate of sodium and superphosphate, is generally the most effective manuring for a cereal crop.

Meadow Hay.—The grasses which form the main bulk of hay belong to the same family of plants as the cereal crops; the seed, however, in grass bears such a small proportion to the stem and leaf that meadow hay may be regarded as a straw crop. In accordance with this character hay is found to contain a much larger proportion of potash and lime than cereal crops, and a much smaller amount of phosphoric acid.

The roots of grass being far shorter than those of the cereals are less able to collect ash constituents from the soil; if, therefore, grass is mown for hay, manures containing potash, lime, and phosphoric acid will generally be required. Like the cereal crops, grass is greatly

increased in luxuriance by the application of soluble nitrogenous manures.

Farm-yard manure, or the feeding of cake, grain, or roots on the land, is the most appropriate manuring for permanent pasture, if quality as well as quantity of produce is considered. Large crops of hay may be obtained by manuring with nitrate of sodium, together with kainit and superphosphate, but a continuance of such treatment promotes a coarse herbage.

The natural clovers of a meadow are detroyed by the continued application of highly nitrogenous manures, a hay consisting almost exclusively of grass being produced. The clovers are developed by the application of manures supplying potash and lime, and by pasturing instead of mowing.

The perennial character of grass, and the abundance of humus in a pasture soil, present favorable conditions for the collection of nitrogen from the atmosphere; this takes place to a greater extent on pasture land than with most other crops.

Leguminous Crops.—Some of these are grain crops, as beans and peas; others are fodder crops, as red clover, sainfoin and lucerne. A striking characteristic of all these crops is the large amount of nitrogen which they contain, the quantity being about twice as great as that found in cereal crops. The quantity of potash and lime in leguminous crops is also very large. The relative proportion of these two bases varies much in crops grown on different soils; upon a calcareous soil, lime will preponderate in the crop, but on a clay soil potash. The lime is found chiefly in the leaf. Silica is nearly absent in leguminous crops.

The nutrition of leguminous crops is not at present perfectly understood. A good crop of red clover, when cut for hay, removes a large quantity of nitrogen from the land, but it nevertheless leaves the surface soil actually richer in nitrogen than it was before from the residue of roots and stubble left in the soil. From whence is this large quantity of nitrogen obtained? It must be procured either from the subsoil, or the atmosphere. The former seems the more probable, as experiments have hitherto failed to prove that leguminous plants have any special power of obtaining nitrogen from the air. The question is further complicated by the fact that nitrogenous manures generally produce but little effect upon leguminous crops. It seems pretty certain that leguminous crops possess to some extent a distinct source of nitrogen; they are probably capable of feeding on some compounds of nitrogen and carbon which are comparatively useless to other crops, and hence the facility with which they acquire nitro-

gen from the soil. A deeply rooted crop like red clover collects nitrogenous compounds from the subsoil, and accumulates nitrogen at the surface in the form of a crop.

The particular food supply of a leguminous crop becomes exhausted by repeated cropping, and the land is said to be "clover" or "bean sick;" no means of remedying this condition is known save by the growth of other crops for a series of years.

Potash manures have generally a very beneficial effect upon leguminous crops; they fail, however, to cure clover sickness. Gypsum is also valuable, though to a less extent.

Root Crops.—All these crops contain a large amount both of nitrogen and ash constituents; among the latter potash greatly preponderates. Turnips contain more sulphur than any other farm crop.

The turnip and mangel crop differ in several respects. Turnips and swedes draw their food chiefly from the surface soil. Their power of taking up nitrogen from the soil is distinctly greater than that of the cereal crops. Turnips are also well able to supply themselves with potash when growing in a fertile soil, but they have singularly little power of appropriating the combined phosphoric acid of the soil; fresh applications of phosphatic manures thus always produce a marked effect on this crop.

Mangels have far deeper roots than turnips, and also a longer period of growth. They have a great capacity for drawing food from the soil, including both nitrogen, potash and phosphoric acid. When carted off the land they are probably the most exhaustive crop that a farmer can grow. As mangels have not the same difficulty that turnips have of attacking the combined phosphoric acid of the soil, phophatic manures are, in their case, of much less importance. Purely nitrogenous manures, as nitrate of sodium, when applied alone to mangels, generally produce a great effect on the crop; this is not the case with turnips, which require phosphates as well as nitrogen in their manure.

As both turnips and mangels consume extremely large amounts of plant food, a liberal general manuring with farm-yard manure is in most cases essential for the production of a full crop; but the special characteristic of the manure for turnips should be phosphatic, and of that for mangels nitrogenous.

Potatoes are surface feeders, and require a liberal general manuring to ensure an abundant crop.

As both root crops and potatoes require large supplies of potash, kainit will be found of service on land naturally poor in that ingredient. It will be chiefly required when the crops are raised with artifi-

cial manures only, as farm-yard manure will always supply a considerable amount of potash.

Forest Growth.—The figures given in the table represent the composition of the produce of beech, spruce fir and Scotch pine forests felled for timber, and are the results of extensive investigations made in Bavaria. Nitrogen, sulphur and chlorine determinations are wanting.

The amount of dry matter in the annual forest growth is in excess of that yielded by any of the cultivated crops given in the table, excepting mangels. This large produce is obtained by a very small consumption of soil food; the amounts of potash and phosphoric acid required are especially far less than in the case of any farm crop. The greater part both of the ash constituents and nitrogen is found in the fallen leaves; if these are left undisturbed, and allowed to manure the ground, the requirements of the forest become extremely small. It appears that about 3,000 lbs. of perfectly dry pine timber are produced with a consumption of only 2 1-2 lbs. of potash, and 1 lb. of phosphoric acid per acre per annum; with beech timber the quantities required are rather larger. The nitrogen contained in timber is very small in amount but the actual quantity required by a forest has not been accurately ascertained. The growth of the forest timber is plainly far less exhaustive to the soil than ordinary farm culture. The demand on the soil becomes, however, considerably greater if the trees are cut when young, young timber and small branches being far richer both in nitrogen and ash constituents than the mature wood.

Adaptation of Manure to Crops.—The true economy of manure can be understood only when we are acquainted with the special characters of the crops we cultivate. The composition of a crop is no sufficient guide to the character of the manure appropriate to it, even when we possess in addition the composition of the soil on which it is to be grown. It is not only the materials required to form a crop, but the power of the crop to assimilate these materials which must form the basis of our judgment. This fact has been much overlooked by many scientific writers, who have counselled farmers to manure their land in every case with all the constituents required by the crop, a proceeding both impracticable and unnecessary. In the case of a barren sand it may indeed be requisite to supply all the constituents of plant food before a crop can be grown, but such a case is far from the circumstan es of ordinary agriculture.

When land is in a fertile condition the total amount of plant food available for crops is very considerable, and luxuriant growth may be

obtained by supplementing the stores of the soil with the few particular elements of food which the crop it is wished to grow has most difficulty in obtaining. Thus, in a large majority of cases, a dressing of nitrate of sodium and superphosphate will ensure a full crop of wheat, barley or oats, and in many cases nitrate of sodium alone will prove very effective. These cereal crops generally find the supply of nitrates in the soil insufficient for their full growth, and the supply of phosphates more or less inadequate; but in a majority of cases they are well able to obtain a sufficient supply of potash, and other essential elements of food. We are thus able, by supplying one or two constituents of the crop, to obtain a luxuriant harvest. In the same way nitrate of sodium employed alone will, in most cases, produce a large crop of mangels; superphosphate alone, a large crop of turnips; while potassium salts alone may be strikingly effective with pasture and clovers.

This special manuring for each crop is no strain on the capabilities of the soil if a rotation of crops be followed. If superphosphate is applied for the turnips, potash for the seeds, and a nitrogenous manure for the cereal crops, the more important elements of plant food contained in the soil will not be diminished at the end of the rotation. At the same time the most economic result will have been obtained from the manures employed, for each manure will have been supplied to that particular crop with which it yields the most remunerative result.

It is doubtless possible by means of rotations manured on the above principles to farm successfully with the sale of all the crops produced, and without the use of farm-yard manure; this is possible at least so long as artificial manures can be obtained at a low price. In the majority of cases, however, the special manuring will only be required to supplement the general manuring by farm-yard manure. Under these circumstances it would seem best, from a chemical point of view, to apply the farm-yard manure to those crops which most require potash, or which stand most in need of a general manuring; such crops would be pasture, seeds, turnips and potatoes.

The economic value of potash manures varies much on different soils. As potassium salts are an expensive manure, the farmer should always ascertain by means of small field experiments whether they will, in his case, yield a remunerative result, before employing them on any large scale.

As the whole object of artificial manuring is to supplement the deficiencies of the soil, it is highly desirable that a farmer should ascertain by trials in the field what is the actual amount of increase which he obtains from the application of the manures he purchases. A few

carefully made experiments will teach him what his land and crops are really in need of. Should he add superphosphate with the nitrate of sodium for his wheat? What dressing of the nitrate is most economical? Is superphosphate alone sufficient for his turnip crop, or should guano or nitrate be employed as well? What is the smallest quantity of superphosphate sufficient for the crop? Will it pay to use potassium salts for his seeds or pasture? These and many other questions can only be answered by trials on his own fields, and on the farmer's knowledge of such facts will depend the economy with which he is able to use purchased manures.

Influence of Climate and Season.—The influence of weather upon crops is far greater than the influence of manure.

As a plant contains water as its largest constituent, and as the whole of the plant food obtained from the soil is taken up through the medium of water, while the amount of water daily lost by the plant through evaporation is very large, the necessity of a sufficient supply of water in the soil during the growing period of a crop is very evident. On the other hand, an excess of water in the soil prevents root development and causes a loss of nitrates and other soluble plant foods in the drainage water. Deeply-rooted crops, as wheat, red clover and mangel, are those best fitted to resist drouth, while shallow-rooted crops, as grass and turnips, are those which suffer most from it.

We have already seen that carbon, which forms the largest ingredient of all vegetable substances, is obtained by plants exclusively from the atmosphere under the influence of light, and that a certain temperature is necessary for this assimilation of carbon, and for the other chemical processes which proceed in a growing plant; a sufficient supply of light and heat is therefore plainly required for the production of a crop. In a season of deficient light and heat the harvest is always late, growth having taken place more slowly than in an average season. In the case of extremely cold and cloudy summers the whole season may be too short for maturing the crop, and the seed in consequence may never be fully ripened.

Each crop requires more or less a different climate for its perfect development; a knowledge of the kind of climate best suited to each crop is of great service in selecting crops for any particular district. Thus wheat requires hot and dry weather for its ripening period, while oats will ripen in a moist atmosphere. Mangels require heat and can resist drouth, while turnips develop best in a cool, moist air.

The soil best furnished with plant food is the one which will yield the best results in adverse seasons, the crop having a greater amount of vitality, and being able to turn to the best advantage the short

periods of favorable weather that may occur. Poor soils yield their best results in seasons of slow but continued growth, the crop having a longer time to collect the scanty supply of food which the soil contains. In hot seasons, with an early harvest, only soils well supplied with food can produce full crops.

The character of the winter has often considerable influence on that of the following season. In a wet winter the soil may lose nitrates by drainage to a considerable extent. Root development will also be prevented by excessive wet. After such a winter the wheat crop generally is in a backward condition, and finds itself in an impoverished soil. The injurious effects of severe frosts are well known.

CHAPTER V.

ROTATION OF CROPS.

The aim of rotations—Results of bare fallow—Effect of green crops, fed on the land or plowed in—Distinctive characteristics of crops—Differences in periods of growth, depth of roots, powers of assimilation and quantity of food demanded—Losses to the land during rotation—Actual loss in an assumed four-course rotation—Probable gain of nitrogen from the atmosphere—Sale of produce other than corn and meat.

It is by no means impossible to grow the same crop with success year after year on the same land; ordinary pasture is indeed an example of continuous cropping. The Rothamsted experiments show that excellent crops of wheat, barley and mangel may be continuously obtained if appropriate manure is annually applied and the land kept free from weeds. A rotation of crops is resorted to in ordinary practice from the facilities which such a plan affords for cleaning the land, and from the greater economy of manure which results from this practice. One of the principal aims of a rotation is to bring the land from time to time into a condition suitable for growing cereal crops; this suitable condition consists mainly in the accumulation of nitrogenous plant food in the surface soil.

Bare Fallow.—A bare fallow is one of the oldest modes of preparing soil for wheat. The soil is plowed, and exposed a whole year to atmospheric influences, and finally sown with wheat. In the case of a clay soil, this treatment would probably lead to the following results: 1. An improvement in the mechanical texture of the soil. 2. The disintegration of some of the mineral silicates, whereby potash and other necessary ash constituents of plants would be liberated and made available for vegetation. 3. The absorption of ammonia from the atmosphere by the soil. 4. The receipt of both ammonia and nitric acid from the air in the form of rain. 5. The oxidation of ammonia and of the vegetable remains in the soil, nitric acid being produced.

The production of nitric acid is probably the most important result of a bare fallow. In soils at Rothamsted left as bare fallow, there has been found at the end of summer 34—55 lbs. of nitrogen per acre in the form of nitric acid in the first 20 inches from the surface. Supposing

the season of fallow is a fairly dry one, the increase in the available nitrogenous food will probably enable the soil to produce twice as much wheat as it could do without this treatment. If, however, the soil is exposed to heavy rain, the nitrates produced will be more or less washed out, and the benefit of the fallow greatly diminished. Bare fallow can be used systematically with advantage only on clay soils having a considerable absorptive power for ammonia, and in a tolerably dry climate; under other circumstances a continance of the practice must issue in a serious loss of soil nitrogen.

Green Crops.—The most usual plan for bringing land into condition for the growth of cereals is the cultivation of green crops. These may be plowed in, forming what is termed green manuring; or consumed on the land by the farm stock; or the crop may be removed, consumed in cattle-sheds or in the farm-yard, and the resulting manure brought on to the land. The principle in every case is that the constituents of the crop shall be returned to the soil.

Let us suppose that land is laid down with seeds, which after two or three years are plowed up, and a cereal crop taken. While the land is continuously covered by vegetation the loss of nitric acid by drainage will be reduced to a minimum. If the grass is fed off on the land, the surface soil will at the end of the three years be considerably enriched both with ash constituents and nitrogen. The former have been collected from the subsoil by the roots of the crop, and returned to the surface as animal manure. The latter includes the accumulated receipts from the atmosphere during the three years, minus the quantity lost by drainage and that assimilated by the animals. The accumulated nitrogen will be chiefly in the form of grass roots, stems and humus. When such land is plowed up, the vegetable matter and humus are oxidized, and gradually yield their nitrogen as nitric acid.

Such a mode of cropping has an advantage over a bare fallow in several ways: 1. The land is turned to profitable use, food being produced for the farm stock. 2. Both ash constituents and nitrates are collected from the subsoil and brought to the surface. 3. The nitrogen is kept in an insoluble form, as vegetable matter, and consequently cannot be washed away, but accumulates to a greater extent than in a bare fallow. 4. Humus is produced, the beneficial actions of which have already been noticed. We have laid no stress on the enrichment of the land by means of ammonia taken up from the atmosphere by the leaves of the crop, for nothing is known as to the quantity of nitrogen which crops may thus acquire.

It follows from what we have just stated that the benefits resulting from the growth of a green crop in a rotation are greater in pro-

portion as its period of growth is longer, and its roots deeper. The more these conditions are fulfilled the larger will be the accumulation at the surface both of nitrogen and ash constituents, and the greater consequently the increased fertility of the soil.

Leguminous crops, as already mentioned, have a special power of accumulating nitrogen in the surface soil, and are hence of the greatest value in a rotation. Red clover is the most striking instance of this action. Its roots extend further perhaps than those of any other farm crop, and being biennial it has a long period for growth. The accumulation of nitrogen at the surface in the form of roots, stubble, and decayed vegetable matter, is in the case of a good crop of clover so considerable, that the whole of the above ground growth may be removed as hay, and the land yet remain greatly enriched with nitrogen, and in an excellent condition for producing a crop of wheat.

The plowing in of green crops has some advantages over the feeding of crops on the land. By this mode of proceeding the whole of the crop is returned to the soil, whereas in feeding a small part of the nitrogen and ash constituents is retained by the animal. The characteristic advantage of green manuring lies, however, in the large amount of humus which the soil acquires. All the carbon which the crop has obtained from the atmosphere is in this case incorporated with the soil, instead of being consumed by the animal. Green manuring is especially adapted for light sandy soils, which need humus to increase their retentive power.

Having glanced at the general advantages to be derived from alternating green crops with cereals, we will consider next the characteristics of different crops which specially fit them to succeed or prepare for each other.

Distinctive Characteristics of Crops.—Differences in their periods of growth occasion a marked distinction in the relation of different crops to soil nitrogen. Thus the fact that the active growth of the cereals commences in spring, and concludes at their time of blooming towards the end of June, places these crops at a disadvantage as to the supply of nitrates from the soil. The autumn and winter rains have frequently washed out the greater part of the nitrates contained in the soil before the growth of the cereal crop commences, and nitrification in the soil has not long recommenced its activity in summer time when the crop becomes too mature to appropriate fresh supplies of nitrogen. Continuous wheat cropping thus results in a gradual impoverishment of soil nitrogen by winter drainage, over and above the nitrogen actually removed in the crops, and thus necessitates a

considerable application of nitrogenous manure if fertility is to be maintained.

A root crop sown in early summer, on the other hand, has at its disposal all the nitrates that would be available for wheat or barley, and in addition, the large supply of nitrates formed in the soil during summer and early autumn. A great part of the nitrates which would be lost in cereal cultivation is thus assimilated and retained by a root crop, and such crops are found to stand in less need of nitrogenous manure than cereals. By consuming the roots on the land the nitrates collected by the crop are returned to the soil in the form of animal manure, and the land thus prepared to carry a cereal crop. Similar remarks might be made respecting other green crops whose active growth extends into the autumn. *

Another important difference between crops lies in their range of roots. Deeply rooted crops, as red clover, sainfoin, rape and mangel, and among the cereals wheat and rye, are to a considerable extent subsoil feeders, and have a greater power of obtaining ash constitu ents from the soil than shallow-rooted crops, as white clover, potatoes, turnips and barley. In accordance with this we find that superphosphate is a very effective manure for the last three crops, but is much less required by such crops as mangel or wheat. By growing deeply-rooted crops as part of a rotation the subsoil is made to contribute to the general fertility. Shallow-rooted crops, on the other hand, have generally a special faculty for appropriating food accumulated at the surface, and are often of great use in this respect, as when barley is made to follow turnips fed off on the land.

Very little is definitely known as to the capacity of different crops for assimilating different forms of plant food, but there can be no doubt that this also is one of the distinctions between various crops, and one reason of the economy of a rotation. The most plainly marked distinction as to mode of feeding is afforded by the behavior of various crops towards silica. Graminaceous crops, as the cereals and grasses, are apparently capable of assimilating certain of the silicates contained in the soil; other crops exhibit no such capacity. In such a case it is easy to imagine that an alternation of cereals with crops of a different description may be for the benefit of both, each drawing to some extent upon distinct supplies of food. Again, leguminous crops are clearly able to assimilate nitrogen to a far greater extent than cereals, and probably in some measure from a different source. If crops of winter beans and winter wheat are grown on similar unmanured land, the bean

* The writer is indebted to Mr. Lawes for the important ideas contained in the two preceding paragraphs.

crop will generally contain twice as much nitrogen as the wheat. The land is not, however, impoverished for wheat by the growth of beans, for wheat after beans will be a far better crop than wheat after wheat, thus affording a striking example of the advantages of rotation.

The quantities of plant food required by different crops are given in the table printed on page 42; these also furnish reasons for the alternation of crops. It will be seen, for instance, that the cereals require but little potash and lime, while root crops, beans and clover, demand a large supply; it is obvious, therefore, that the resources of the soil are husbanded by growing these two classes of crops in alternation, the greater demand for potash and lime thus falling every alternate year.

The net result of a judicious alternation of crops, in which the special characteristics of each are turned to good account, is the production of a maximum total yield of produce with a minimum amount of manure.

Losses to the Land During Rotation.—The table showing the composition of ordinary farm crops will supply the requisite information as to the loss which a farm may suffer by the sale of individual crops. We will now consider briefly the losses during a rotation.

The conservation of plant food on a farm is generally effected by confining the exports to grain and meat, the rest of the produce being consumed by the stock, and the manure returned to the land. Let us assume that a farm is managed on the four-course system, and that the average crops obtained per acre are—swedes, 14 tons; barley, 40 bushels; seeds (half clover, half grass), 3 tons of hay; and wheat, 30 bushels. Further, that nothing is sold save grain and meat; that 2 bushels both of wheat and barley are returned to the land as seed; that 700 lbs. of linseed cake are fed with each acre of swedes; that 110 lbs. of oats are purchased per acre per annum for the horses. Finally, that half a ton of straw is fed per acre in the course of the rotation, and the rest used as litter. The soil will, in this case, suffer the following losses of nitrogen, phosphoric acid and potash, in the course of a four years' rotation:

LOSSES PER ACRE DURING A FOUR-COURSE ROTATATION,

	Nitrogen.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.
By feeding Swedes, 14 tons	11.1	1.89	0.24
By sale of Barley, 38 bushels	32.3	14.35	9.60
By feeding Seeds, 3 tons hay	18.7	3.20	0.40
By sale of Wheat, 28 bushels	30.8	13.35	9.05
By feeding Straw, ½ ton	0.7	0.12	0.02
	93.6	32.91	19.31
Deduct Manure from 440 lbs. Oats, and 700 lbs. Oil-cake	36.8	14.61	12.02
Total loss in 4 years	56.8	18.30	7.29
Average loss each year	14.2	4.57	1.82

These losses assume that the farm-yard manure is properly made, and returned to the land without waste. If the manure has suffered loss by drainage the estimates given would have to be increased.

The loss of potash is extremely small, and may generally be quite disregarded. If, however, no cake is used, and the land is poor in potash, the loss might be replaced by the use of 1 cwt. of calcined kainit for the seeds.

The loss of phosphoric acid would be more than replaced, even if no cake were employed, by the use of 2 cwt. of superphosphate for the swedes.

The loss of nitrogen by the sale of crops and meat is seen to be far more considerale than the loss of phosphoric acid or potash. The figures given are also below the truth, as they do not take into account the nitrates lost to the soil by drainage. Against this loss of nitrogen we have to place the amount unnually supplied to the land by the rainfall, say 6—8 lbs. per acre, and also the unknown quantity absorbed as ammonia from the atmosphere by soil and plant; this latter amount will vary with the nature of the soil and climate, and probably also with the character of the cropping. We may, however, safely assume that with the cropping and manuring supposed in the preceding table the total gain of nitrogen from the atmosphere will balance the loss, so that under good management the rotation might be indefinitely continued without diminishing the fertility of the land.

In the four-course manured rotation upon the heavy land at Rothamsted, the nitrogen annually removed in the crops, on an average of thirty-two years, has exceeded by about 35 lbs. the quantity supplied

in the manure. If the crops on this experimental rotation should be permanently maintained in quantity, of which at present we cannot be certain, we must conclude that this 35 lbs. of nitrogen, together with the unknown additional quantity lost as nitrate by drainage, have been annually derived from the atmosphere—partly as rain, but mostly by direct absorption by soil or crop. It appears very probable that on many soils the amount of nitrogen contributed by the atmosphere in the course of a rotation is very considerable.

We have supposed that only grain and meat are sold off the land during the rotation; it will often be economical to sell a larger part of the produce, and to purchase manure in its place. The sale of straw will be attended with little practical loss on heavy land; but on light land both the loss of potash, and the diminution in the bulk of the manure will be more or less felt. The sale of hay or roots is far more exhaustive, and except on the most fertile soils, must demand a considerable purchase of manure or cattle food to replenish the soil with plant nourishment.

CHAPTER VI.

ANIMAL NUTRITION.

The Constituents of the Animal Body.—Water, albuminoids, gelatinoids, horny matter, fat, and ash constituents—Composition of animals in various stages of growth and fattening—Proportion of carcass—Composition of increase while fattening. *The Processes of Nutrition.*—The constituents of food, and their particular functions in the body—Digestion—Respiration—Excretion.

In order to understand the mode in which animals are nourished we must first obtain some acquaintance with the nature of the animal body, and understand the composition of the increase which takes place during growth and fattening.

The Constituents of Animals.—The elements composing the animal frame are the ten already named as forming the essential constituents of plants with sodium and chlorine in addition. The two last named elements are commonly present in the succulent parts of plants, but are apparently not essential to plant life—in the animal frame they are, however, indispensable. Fluorine and silicon are also always found in the animal body, but are not known to be essential for life or growth; fluorine occurs in small quantities in the teeth and bones, and silicon in hair, wool, and feathers.

The combustible matter of the animal body is mainly composed of nitrogenous substances, and of fat.

The nitrogenous substances constituting the animal frame may be generally classed as—(1) albuminoids; (2) gelatinoids; and (3) horny matter. These three groups are related in composition, though differing a good deal in their properties. The albuminoids form the substance of animal muscle and nerve, and the greater part of the solid matter of blood; they are, undoubtedly, of the first importance in the animal economy. The gelatinoids form the substance of skin and sinew, of all connective tissue, and also the combustible matter of cartilage and bone. Horny matter, named by chemists keratin, is the material of which horn, hair, wool, and feathers are constituted.

The fats occurring in the animal body are principally stearin, palmitin, and olein. Stearin preponderates in hard fats, and olein in fluid fats.

Of the incombustible constituents by far the largest part is contained in the bones. In fat animals 75 to 85 per cent. of the total ash constituents are found in the bones. Bone ash chiefly consists of phosphate of calcium, with a small quantity of carbonate of calcium and phosphate of magnesium. In muscle by far the most abundant ash constituent is phosphate of potassium. Potassium salts are also abundant in the "yolk" of unwashed wool. Blood, on the other hand, always contains a considerable quantity of sodium salts.

The amounts of water, nitrogenous matter, fat, and ash constituents present in a large number of animals have been determined at Rothamsted. The following table shows the per centage composition of eight animals after deducting the contents of the stomachs and intestines:

PERCENTAGE COMPOSITION OF WHOLE BODIES OF ANIMALS.

	Fat Calf.	Half fat Ox.	Fat Ox.	Store Sheep.	Fat Sheep.	Extra fat Sheep.	Store Pig.	Fat Pig.
Water	65.1	56.0	48.4	61.0	46.1	37.1	58.1	43.0
Nitrogenous matter.	15.7	18.1	15.4	15.8	13.0	11.5	14.5	11.4
Fat	15.3	20.8	32.0	19.9	37.9	48.3	24.6	43.9
Ash	3.9	5.1	4.2	3.3	3.0	3.1	2.8	1.7

The fat pig was one grown for fresh pork, not for bacon.

Water is in nearly every case the largest ingredient of the animal body; the proportion of water diminishes with the growth of the animal, and especially during fattening. Fat forms in most cases the principal solid ingredient of well-fed animals, its proportion increases very largely during fattening. The proportion of nitrogenous matter and ash tends to increase from youth to maturity, but diminishes during fattening.

The largest proportion of nitrogenous matter and of ash are found in the ox, the smallest in the pig. The difference in the proportion of ash is chiefly due to the wide difference in the proportion of bone in these two animals. Fat is found in greatest quantity in the pig, and is least in the ox.

The following table shows the quantity of nitrogen, and of the principal ash constituents, in the fasted live weight of the fat animals analyzed at Rothamsted. For convenience of comparison each animal

is assumed to weigh 1,000 lbs. The table also gives the nitrogen and ash constituents in wool and milk; it thus supplies full information as to the loss which a farm will sustain by the sale of animal produce. The composition of wool is mainly deduced from foreign analyses.

ASH CONSTITUENTS AND NITROGEN IN 1,000 POUNDS OF VARIOUS ANIMALS AND THEIR PRODUCTS.

	Nitrogen.	Phosphoric Acid.	Potash.	Lime.	Magnesia.
Fat Ox.....	23.18	16.52	1.84	19.20	0.63
Fat Sheep.	19.60	11.29	1.59	12.80	0.50
Fat Pig.....	17.57	6.92	1.48	6.67	0.35
Wool, unwashed.....	73.00	1.00	40.00	1.00	0.70
Milk.....	6.40	2 00	1.70	1.60	0.20

These figures show that the ox contains in proportion to its weight a large amount of nitrogen, and a much larger amount of phosphoric acid and lime, than either the sheep or pig. Of all the animals raised on a farm the pig contains least of all the important ash constituents.

The large amount of potash in unwashed wool is very remarkable; a fleece must sometimes contain more potash than the whole body of a shorn sheep.

In a fat ox about 60 per cent. of the fasted live weight will be butchers' carcass; in a fat sheep about 58 per cent.; in a fat pig (fatted for pork) 83 per cent. The proportion of carcass increases considerably during fattening. Thus the carcass in the store sheep killed at Rothamsted average 53.4, in the fat sheep 58.6, and in the very fat sheep 64.1 per cent. of the fasted live weight.

When a lean animal is fattened the larger part of the increase in live weight is carcass. It was found at Rothamsted that in the case of sheep passing from the "store" to the "fat" condition, increasing in weight from 102 lbs. to 155 lbs., about 68 per cent. of the increase was carcass. With "fat" sheep passing to the "very fat" state, increasing from 144 lbs. to 202 lbs. live weight, the proportion of carcass in the increase was about 77 per cent. With a fattening pig, increasing from 103 lbs. to 191 lbs. live weight, the proportion of carcass in the increase was found to be 91 per cent.

The percentage composition of the increase of sheep and pigs when passing from the "store" to the "fat" condition is about as follows. The increase of fattening oxen will have a similar composition:

PERCENTAGE COMPOSITION OF THE INCREASE WHILST FATTENING.

	Water.	Nitrogenous matter.	Fat.	Ash.
Sheep.....	22.0	7.2	68.8	2.0
Pigs.....	28.6	7.8	63.1	0.5

The increase during the fattening stage of growth is thus chiefly an increase in fat, eight or nine parts of fat being laid on for one of nitrogenous matter. The proportion of fat would be somewhat greater still in the increase of highly fattened animals, as for instance, of pigs fed for bacon.

The Processes of Nutrition.—We have already seen that the food of plants is of the simplest character. From such simple substances as carbonic acid, nitric acid, water and salts, a plant is able to construct a great variety of elaborate compounds. It accomplishes these surprising transformations by a consumption of force (sunlight) external to itself. An animal has no such constructive power. The animal frame is built up of substances existing ready formed in the food, or produced by the splitting up or partial combustion of some of the food constituents of the body. The animal also derives little or no aid from external force. The temperature of the animal (about 100° Fahr.) is maintained by the heat generated within the body from the combustion of the food consumed; the force by which all the mechanical work of the animal is performed is also derived from the same combustion of food.* The source of force in the animal is thus purely internal.

It is evident from what has just been said that the food of animals has duties to perform which are not demanded of the food of plants. In plants the food merely provides the matter for building up the vegetable tissues. In the animal, besides constructing tissue, the food has to furnish the means of producing heat and mechanical force.

1. *Food Constituents and their Functions.*—The solid ingredients of animal food may be classed generally as—(1) albuminoids, (2) fat, (3) carbo-hydrates; (4) incombustible matter, or ash. Besides these general ingredients of food we have in immature vegetable products a fifth class—the amides, which also take part in animal nutrition. The albuminoids and amides are nitrogenous substances, the other ingredients of food are non-nitrogenous.

The various albuminoids occurring in grain, roots and other forms

of vegetable food are quite similar in composition to those found in milk, blood and flesh. From the albuminoids of the food are formed not only the albuminoids of the animal frame, but also the gelatinoids, the hair, wool, horn, etc., and to some extent the fat. By the combustion of albuminoids in the body, heat and mechanical force will also be developed. Albuminoids thus supply in themselves most of the requirements of the animal—a statement which can be made of no other food constituent. The albuminoids of food are frequently described in analyses as "flesh-formers."

An animal, even when not increasing in weight, will always require a certain constant supply of albuminoid in its food to replace the waste of nitrogenous tissue which is always going on; the amount thus required is but small; in the case of an adult man at rest it amounts to about fifty grams (3¾ oz.) per day.

When the nitrogenous tissues, or the albuminoids consumed as food, are oxidized in the body, the nitrogen they contain is not burned, but excreted in the form of urea. The urea produced is one-third the weight of the albumin oxidized. When the albuminoids, either of the food or of the wasting tissues, are only partially oxidized, fat as well as urea may be produced. Theoretically, 100 parts of albumin may yield 51.4 parts of fat.

When amides are consumed as food they are burned in the system, and their nitrogen excreted as urea. Amides cannot supply the place of albuminoids as muscle formers, but by combustion they serve for the production of heat and force.

The fatty matter contained in food is similar to that found in the animal body, but an animal is apparently capable of transforming one kind of fat into another. The fat of the food is either burned in the animal system to furnish heat and mechanical energy, or it is stored up as a reserve of force. Fat has a greater value as a heat and force-producer than any other ingredient of food.

The carbo-hydrates of the food include starch, sugar and cellulose; these substances consist of carbon, hydrogen and oxygen, the last two elements being in the proportion to form water—hence the name. Various other non-nitrogenous constituents of food, as pectin, lignose and vegetable acids, are also generally included under this title, though not strictly speaking carbo-hydrates. Carbo-hydrates form the largest part of all vegetable foods. They are not permanently stored up in the animal body, but serve, when burned in the system, for the production of heat and mechanical work. They are also capable, when consumed in excess of immediate requirements, of conversion into fat.

Carbo-hydrates are of less value, for the same weight consumed, than either albuminoids or fat. Frankland found that 100 parts of fat when burned gave the same amount of heat and force as 211 parts of albumin (urea deducted), or 232 parts of starch. It is commonly reckoned that one part of fat is equivalent to 2.44 parts of starch. Cane sugar, according to the Rothamsted experiments with pigs, has the same feeding value as starch. Cellulose, being more difficult of digestion, has probably a smaller value than either.

The amides, carbo-hydrates and fat are quite incapable of adding to the nitrogenous tissues of the body. They may, however, have this effect indirectly by protecting the albuminoids of the food from oxidation. A moderate quantity of albuminoids supplied to a growing animal will thus produce a larger increase of muscle when accompanied by a supply of carbo-hydrates or fat than if consumed alone. In the former case the non-nitrogenous ingredients of the food supply the heat and force demanded by the animal body, in the latter case the albuminoids have to meet every requirement.

If an adult animal receives the small quantity of albuminoids and ash constituents necessary to supply the waste of tissue, the whole of its remaining wants may probably be met by supplies of carbo-hydrates and of fat.

The ash constituents present in the food are the same as those found in the animal body; all that is accomplished by the animal is to select from the supply those of which it is in want.

2. *Digestion.*—The object of digestion is to bring the solid constituents of the food into a form suitable for absorption into the blood. Of the carbo-hydrates of the food some, as sugar, are already soluble and diffusible, and need no digestion; others, as starch and cellulose, are naturally insoluble. The digestion of carbo-hydrates commences with the action of the saliva, which has the property of converting starch into sugar. This action, in the case of ruminants, is prolonged by the temporary sojourn of the food in the first two stomachs, and its return to the mouth in chewing the cud. The further solution of starch and cellulose is effected in the intestines, partly by the pancreatic juice, which has a powerful action on starch, and partly by the fermentive processes which take place.

The albuminoids of the food are attacked by the gastric juice of the stomach (the fourth stomach of ruminants), and converted into peptones, bodies similar to albuminoids in composition, but which, unlike them, are diffusible through a membrane. The pancreatic juice of the small intestines also converts albuminoids into peptones.

Fat, liquefied by the heat of the body, is probably capable of absorption without change. The digestion of fat in large quantities is greatly assisted by the bile and pancreatic juice.

The absorption of the dissolved constituents of the food takes place more or less in all parts of the alimentary canal, but chiefly in the small intestines. The absorbed matters pass into the blood.

The blood of an animal is the source of nourishment to the whole body; out of its ingredients all the tissues are formed. The blood is also the means of conveying the oxygen to the tissues which is essential to their vitality, and of removing from them carbonic acid and the other products of their metamorphosis.

3. *Respiration.*—The blood is supplied with oxygen during its passage through the lungs, where it is brought into contact with air. The oxygen is absorbed by the hæmoglobin, which forms the chief constituents of the red corpuscles. The scarlet blood thus produced is circulated through the whole body by the arteries; the oxygen it supplies is consumed in the tissues, producing, among other results, heat and mechanical work. The blood finally returns from the tissues by the veins. The hæmoglobin has then lost oxygen, and has assumed a purple color; the blood serum also contains carbonic acid gas in solution, and many other products of decomposition. By passing again through the lungs the carbonic acid is more or less completely discharged, and a fresh supply of oxygen obtained.

4. *Excretion.*—The products which result from the oxidation of tissue, or of the food consumed, are removed from the body by the lungs, the kidneys or the skin. The chief products of oxidation in the body are carbonic acid, water, urea and salts. Carbonic acid is removed through the lungs, and to a smaller extent by the skin; urea and salts by the kidneys; water by all the organs of excretion.

Non-nitrogenous substances, as fat and sugar, when oxidized in the body, yield simply water and carbonic acid. The nitrogen of the albuminoids, gelatinoids and amides is not oxidized, but is excreted in the form of urea. The sulphur of the albuminoids is apparently oxidized to sulphuric acid.

The quantity of nitrogen in the urine is a measure of the albuminoids, gelatinoids and amides oxidized in the body. In the urine are also removed all the salts not required for the animal economy; sodium and potassium salts are generally abundantly present.

The solid excrement contains the undigested parts of the food, with the residues of the bile, and other secretions of the alimentary canal.

CHAPTER VII.

FOODS.

The Composition of Foods.—Detailed composition—Proportion of nitrogen existing as true albuminoids—Variation in foods due to age and manuring—Proportion between nitrogenous and non-nitrogenous constituents—Ash constituents. *Digestibility of Foods.*—Method of determination—Experiments with ruminants—Influence of age of the animal, daily ration, and labor—Influence of the maturity of fodder crops on their digestibility—Influence of one food on the digestibility of another—Common salt—Experiments with horses—Experiments with pigs—Experiments with geese. *Comparative Nutritive Value of Foods.*—Influence of proportion of water—Comparative heat and work-producing power—Proportion of albuminoids to non albuminoids—General conclusions.

In the preceding chapter we have enumerated the chief constituents of food, and described their functions in the animal body; we may now proceed a step further, and consider the detailed composition and feeding value of the foods actually employed on the farm.

The nourishing value of a food is plainly fixed by two factors:—1. Its composition. 2. Its digestibility. The first of these determines the character of the food—its richness in albuminoids, fat, carbo-hydrates, and ash constituents. The second determines the extent to which these various contituents are made use of in the animal body.

Composition of Foods.—The average percentage composition of the foods commonly given to farm animals is shown in the following table. The figures given are in every case the means of a large number of analyses:

PERCENTAGE COMPOSITION OF ORDINARY FOODS.

Food.	Water.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.	Ash.
Cotton-Cake (decorticated)	10.0	41.2	14.0	18.0	9.0	7.8
Cotton-Cake (undecorticated)	11.5	24.6	6.2	30.2	20.8	6.7
Linseed-Cake	12.0	28.1	12.0	30.3	11.0	6.6
Beans	14.5	25.5	1.6	45.9	9.4	3.1
Peas	14.3	22.4	2.0	52.5	6.4	2.4
Oats	13.0	12.9	6.0	53.8	10.8	3.5
Wheat	14.4	11.3	1.5	68.1	3.0	1.7
Barley	14.0	10.6	2.0	63.7	7.1	2.6
Maize	11.4	10.4	5.1	68.5	3.0	1.6
Malt Dust	9.5	23.7	2.2	44.9	12.5	6.8
Wheat Bran	14.0	14.2	4.2	50.4	11.1	6.1
Brewer's Grain	77.4	4.8	1.4	9.7	5.3	1.5
Clover Hay	16.0	12.3	2.2	38.2	26.0	5.3
Meadow Hay	14.3	9.7	2.5	41.0	26.3	6.2
Bean Straw	16.0	6.3	1.0	36.7	35.0	5.0
Wheat Straw	14.3	3.0	1.5	32.6	44.0	4.6
Meadow Grass	80.0	3.5	0.8	19.2	4.5	2.0
Green Clover	83.0	3.3	0.7	7.0	4.5	1.5
Potatoes	75.0	2.1	0.3	20.5	1.1	1.0
Mangels	88.5	1.2	0.1	8 2	1.0	1.0
Swedes	89.3	1.5	0.2	7.3	1.1	0.6
Turnips	91.7	1.1	0.2	5.3	1.0	0.7

The soluble carbo-hydrates in the above table include starch, pectin, and the finer parts of the fibre; these are not soluble in water, but are dissolved by the weak acid and alkali employed by the analyst to separate the coarse fibre.

The whole of the nitrogen present in the foods above mentioned has been reckoned as existing as albuminoids. We are obliged to adopt this usual mode of calculation for the sake of uniformity, the amount of true albuminoids having been determined only in the case of a few of the foods enumerated.

It has been shown during the last few years that a part of the nitrogen in many foods exists, not as albuminoids, but as amides (*e. g.*, asparagine and glutamine) and as nitrates. The subject is at present receiving the attention of chemists. It appears that in seeds nearly the whole of the nitrogen exists as albuminoids, and this is especially true of the kernel of the seed. Thus in wheat flour about 90 per cent. of the nitrogen present is in the form of albuminoids, while in the bran which forms the skin of the grain only about 70 per cent. of the nitro-

gen is in this condition. For the various cakes and grains mentioned in the table the figures given for albuminoids will be approximately correct, but for the other foods the figures are undoubtedly too high. In hay it would appear, from the few determinations made, that about 80 per cent. of the nitrogen is present as albuminoids. In malt-dust about 73 per cent. of the nitrogen is albuminoid. In potatoes about 60 per cent. of the nitrogen is in this condition. The few determinations made in swedes show about 45 per cent. of the nitrogen as albuminoids. While in mangels generally only about 25 per cent. of the nitrogen is in this form.

The composition of all vegetable foods is liable to variation, depending on the state of maturity of the plant, and the character of the soil and season. In the case of perfectly matured produce, as, for instance, ripe seed, the variations in composition are not generally considerable, and an average composition, such as is given in the table, will be found in most cases pretty correct. But in the case of immature produce, such as meadow grass, turnips, or mangels, the composition largely depends on the stage of growth in which the plant is taken, and is also greatly affected by the character of the manuring. It may be generally stated that as a plant matures the proportion of water, nitrogenous matter, and ash constituents diminishes, while the proportion of carbo-hydrates largely increases. At the same time the amides become more or less converted into albuminoids.

The following table shows the percentage composition of meadow grass cut at three different dates in the same field. The first cutting will represent pasture grass fed off in the green state by stock; the second cutting is good ordinary hay; the third cutting is an over-ripe hay, somewhat coarse and stemmy, but well harvested. The composition given in every case is that of the dry substance:

COMPOSITION OF HAY HARVESTED AT DIFFERENT DATES.

Date of Cutting.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.	Ash.
May 14.....	17.65	3.19	40.86	22.97	15.33
June 9.....	11.16	2.74	43.27	34.88	7.95
June 26.....	8.46	2.71	43.34	38.15	7.34

Young grass is thus much richer in albuminoids,* and contains a smaller proportion of indigestible fibre than older grass, and is consequently more nourishing. The same comparison may be made between young clover and that which is allowed to mature for hay. Hay should always be cut immediately full bloom is reached; after this point the quality of the crop will considerably deteriorate.

While fodder crops deteriorate towards maturity, from the conversion of soluble carbo-hydrates into fibre, crops, such as potatoes and mangel improve, the carbo-hydrates produced in their case being respectively starch and sugar, both of them substances of great feeding value.

The influence of high manuring is naturally to increase the luxuriance of a crop; a luxuriant crop will always contain more water than one in less active growth. Very large mangels often contain only six per cent. of dry matter, while in quite small roots the proportion may be as high as fifteen per cent. Luxuriance also retards maturity. A heavily manured mangel will contain, at the same date, a much smaller proportion of sugar than a similar mangel grown on poor soil. The result of high manuring is thus not only to increase the bulk of the crop, but also generally to diminish the proportion of carbo-hydrates and increase the nitrogen, ash constituents and water. In highly manured crops a smaller proportion of the nitrogen will exist in albuminoids than in crops less heavily manured and more mature.

In the case of hay, the composition is further affected by the conditions of harvesting. Grass that has suffered from rain during haymaking will contain less soluble matter (carbo-hydrates and albuminoids) than well-made hay; this loss will be greatly increased if the hay has been long in the field and undergone fermentation as well as washing.

Having pointed out the variations which are liable to occur, we may now consider the average composition of the various foods shown in the table.

The amount of total dry matter is seen to be tolerably uniform throughout the various classes of dry foods, the foods richest in fat being generally the driest. In the green fodder and roots the proportion of water is generally very large; potatoes contain the most, and white turnips the least proportion of dry matter.

We have already seen that albuminoids and fat are the most con-

* It must be borne in mind that in the present transition state of our analyses of food the term "albuminoids" will generally include all the nitrogenous substances present.

centrated forms of food which an animal can consume; those foods which are rich in albuminoids and fat are therefore those which, generally speaking, have the highest nourishing value. At the head of all foods in this respect stand the various descriptions of oil cake; they are, without doubt, among the most concentrated foods at the farmer's disposal. The leguminous seeds, as beans, peas and lentils, are rich in albuminoids, but not in fat. The cereal grains are much poorer in albuminoids, containing only about one-half the proportion found in leguminous seeds. Of the common cereals, oats are generally the most nitrogenous and maize the least. Oats and maize are characterized by containing more fat than the other cereal grains. The special characteristic of all the cereal grains is their richness in an easily digested carbo-hydrate, starch.

Of the three cereal products mentioned in the table the bran and brewer's grains represent respectively the husk of wheat and barley. These foods are richer both in nitrogenous matter and fat, but contain a much more considerable proportion of fibre than the whole grain. Malt-dust (known also as malt-combs) consists of the radicles of the germinated barley, which are removed after the malt has been dried. This material is very rich in nitrogenous matter.

When we turn to the hay, straw, green fodder, and roots, the general composition becomes a less safe guide to the nourishing value. The nitrogen, we have already seen, is here no certain measure of the proportion of albuminoids present. The fat credited to these foods is also largely composed of waxy matters, and we can hardly attribute to it the same feeding value as to an equal amount of fat in oil-cake or maize. The carbo-hydrates also include various substances of little or no feeding value. The same weight of dry matter in crude foods of this class has thus a decidedly less nourishing value than in foods consisting entirely of matured grain. Foods belonging to different classes cannot safely be compared on the basis of their composition.

An important element in the character of a food is the proportion between its nitrogenous and non-nitrogenous constituents, these two classes of ingredients performing to a considerable extent distinct functions in the body. To find this proportion it is usual to calculate the fat into its equivalent in starch (generally done by multiplying the fat by 2.44), and add the product to the other carbo-hydrates of the food; the relation of the albuminoids to the total non-nitrogenous constituents reckoned as carbo-hydrates is then easily found. The relation in question is commonly known as the "nutritive relation" of the food (Nahrstoffverhaltniss), but is better described as the "albuminoid ratio." Thus the composition of wheat grain in the table shows an

"albuminoid ratio" of 1:6.6, and the composition of decorticated cotton-cake an albuminoid ratio of 1:1.5. Figures so calculated are, however, only approximate, as we ought clearly only to take account of the constituents actually digested by the animal. We shall therefore refer to the subject again further on.

Most foods supply a sufficient quantity of the ash constituents which are required for the formation of bone and tissue; the chief of these are phosphoric acid, lime and potash.

The oil-cakes and bran are the foods richest in phosphoric acid; straw and meadow hay are the foods poorest in this constituent. Lime is most abundant in clover hay, bean straw and turnips, and occurs in least quantity in the cereal grains and in potatoes. Potash is abundant in roots, hay, bean straw, bran and oil-cake, and is found in smallest quantity in the cereal grains.

Of all the ash constituents lime and soda are probably the most generally deficient. Maize is of all ordinary foods (rice excepted) the poorest in lime; it certainly contains too small an amount for a rapidly growing animal. At Rothamsted a mixture of coal ashes, common salt, and superphosphate was used with advantage in the case of pigs fed solely on maize. It must be recollected, however, that animals will generally receive no inconsiderable amounts of lime in their drinking water.

The proportion of phosphoric acid and potash in various foods is shown in table hereafter.

Digestibility of Foods.—Our knowledge concerning the digestion of food by farm animals is almost entirely derived from German investigation; * much information has already been obtained upon this subject, though a great deal yet remains to be accomplished. The general method of investigation has been to supply an animal with weighed quantities of food, the composition of which has been ascertained by chemical analysis. During this experimental diet the solid excrements are collected and weighed, and are finally analyzed by the same chemical methods previously applied to the food. Subject, therefore, to contain small corrections for intestinal secretions, we obtain by this plan the amount of each constituent of the food which has passed through the animal unabsorbed, and by difference the amount digested. The proportion of each constituent digested for 100 supplied as food is known as its "digestion coefficient."

* The information given in this section is taken almost entirely from the admirable work of Dr. E. Wolff, "Die Ernahrung der Landwirthaftlichen Nutzthiere," with its valuable Supplement just published.

1. *Experiments with Ruminants.*—Ruminating animals possess an extensive digesting apparatus, consisting of the well-known four stomachs, in addition to the intestinal organs. Food takes a considerable time in passing through this system. In changing the food of an ox five days will generally elapse before the remains of the preceding diet are expelled by the animal. Animals of this class are specially adapted for the digestion of bulky foods, containing much fibre.

Experiments have been made with oxen, cows, sheep, and goats. The power of these different animals for digesting food is apparently very similar, but no accurate comparisons have as yet been made. The following table shows the average results obtained with ruminating animals fed on the foods respectively mentioned. The figures given represent the "digestion coefficients" found for each constituent of the food consumed. The "albuminoid ratio" of the digested portion of the food is also given:

EXPERIMENTS WITH CATTLE, SHEEP AND GOATS.

Food.	Digested for 100 of each constituent supplied.					Albuminoid ratio. †
	Total Organic Matter.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.	
Linseed Cake,.....	80	84	90	78	?	1 : 1.7
Beans.....	90	88	99	93	?	1 : 2.1
Oats.....	71	79	84	76	24	1 : 6.5
*Barley.....	81	77	100	87	?	1 : 8.2
*Maize.....	88	79	85	91	?	1 : 7.9
*Wheat Bran.....	67	75	50	70	37	1 : 4.5
Meadow Hay.....	59	56	47	62	57	1 : 9.2
Clover Hay.	59	55	56	69	44	1 : 6.2
Lucerne Hay.....	59	76	38	67	40	1 : 2.8
Oat Straw.....	51	38	30	43	61	1 : 14.7
*Wheat Straw.....	46	20	36	39	56	1 : 44.1
*Bean Straw.....	50	51	55	60	36	1 : 6.2

Roots and potatoes are not mentioned in the table; they are apparently completely digested, with the exception, perhaps, of the small amount of hard fibre contained in the epidermis and rootlets.

The digestibility of the foods in the lower division of the table has been for the most part determined by feeding these animals on these foods alone; the digestibility of the foods in the upper division has been found by supplying them in various proportions along with

*These results are derived from one or two experiments only.

† The numbers in this column refer to the foods actually used in the experiments.

hay, the digestibility of which has been already ascertained with the same animal. The amount of fibre in these last-named foods is usually too small for its digestibility to be determined with certainty by a few experiments

The concentrated foods placed in the upper part of the table are seen to be far more thoroughly digested than is the case with hay or straw. When of good quality, 80 or 90 per cent. of the organic matter of these foods will be assimilated by the animal, except in those cases where much fibre is present. The albuminoids and fat in these foods have especially a greater digestibility than the same ingredients in hay and straw. The hard fibre forming the husk of seeds is apparently but little digestible. The oats employed were of somewhat inferior quality.

In the case of ordinary hay and straw the organic matter digested is but 45 to 60 per cent. of that supplied. The minimum amount digested occurs with wheat straw; oat straw, which is generally cut somewhat more green, is distinctly more digestible. The results given for meadow and clover hay relate to hay of average quality; the lucerne hay was of better quality, and shows a much higher degree of digestibility in the nitrogenous matter.

The higer is the proportion of nitrogenous matter in hay and straw the greater appears to be its digestibility. Thus the wheat straw experimented with contained 4.8 per cent. of nitrogenous matter in its dry substance, of which only one-fifth or 20 per cent. was digested; while good lucerne hay with 19.3 per cent. of nitrogenous matter, had 76 per cent. of this in a digestible form. The precise nature of the digested and undigested nitrogenous matter has not yet been ascertained; amides being soluble bodies have probably been classed in these experiments as digestible albumin.

Of the fibre in hay and staw about 40 to 60 per cent. is generally digested by ruminant animals. The fibre of leguminous hay and straw (clover and lucerne hay, and bean straw) is considerably less digestible than the fibre of similar graminaceous foods (grass hay, oat and wheat straw). It has been shown that both in the case of the soluble carbohydrates, and of the fibre, the portion digested has always the general formula of starch or cellulose, $C_6H_{10}O_5$, while the portion left undigested is much richer in carbon. It appears, therefore, that while cellulose is a digestible substance, the lignose which is deposited in the tissues as the plant increases in age, and which contains a larger proportion of carbon, is indigestible. Chemical analysis shows that the fibre of leguminous hay and straw is richer in carbon, and consequently in lignose, than the fibre of grass hay, or grain straw.

We must now glance at the circumstances which influence the proportion of food digested. The individual character of the animal undoubtedly affects the proportion digested. Of two animals supplied with the same food, one will often persistently digest a larger proportion than the other. In young animals the digestive power is apparently very similar to that of animals of full age. Sheep from six to fourteen months old showed no distinct change in digestive capacity.

Differences in the quantity of the daily ration of hay do not sensibly affect the proportion digested; an animal will not digest more by being starved. Labor also is practically without influence, horses at rest and at work digesting nearly the same proportion of their food. Differences in the quality of a food may, however, exercise a great influence on its digestibility; the addition of another food may also considerably alter the rate of digestion of the first food.

The digestibility of fodder plants is mainly determined by their age; all the constituents of a young plant are more digestible than in the same plant of greater age. The composition of meadow grass cut at three different dates has been already given on page 297; this grass was supplied to sheep in the form of hay, and yielded the following digestion coefficients:

DIGESTION OF HAY BY SHEEP.

Date of cutting.	Proportion of each constituent digested for 100 supplied.				
	Total organic matter.	Albuminoids.	Fat.	Soluble carbo-hydrates.	Fibre.
May 14.....	75.8	73.3	65.4	75.7	79.5
June 9.....	64.3	72.1	51.6	61.9	65.7
June 26.....	57.5	55.5	43.3	55.7	61.1

The diminution in digestibility with the increasing maturity of the grass is very striking, and is very equally spread over all the constituents. Similar experiments with clover cut at different stages of growth have yielded similar results. It follows plainly from what has been now stated that no fixed nutritive value can be applied to fodder crops, or to the hay made from them, as both their composition and digestibility are largely influenced by their age and condition when cut. The young plant is always the most nutritive.

The superior fattening quality of a pasture, as compared with that of the hay made from it, is clearly due to the fact that on land continually grazed the animal is entirely fed on young herbage, while hay will always consist of the fully grown plant.

Fodder crops do not sensibly diminish in digestibility by being made into hay, if haymaking is carefully carried out in good weather. But the loss of the finer parts of the plant by rough treatment, or the washing out of soluble matter by rain, may considerably diminish the digestibility. Hay appears to lose some of its digestibility by keeping.

We now turn the influence of one food on the digestibility of another.

If to a diet of hay and straw, consumed by a ruminant animal, a pure albuminoid, as wheat gluten, be added, the added food is entirely digested without the rate of digestion of the original food being sensibly altered. The same result has been obtained in experiments with pigs. These animals were fed on potatoes, to which variable quanties of meat flour were afterwards added. The albuminoids of the meat were entirely digested, while the proportion of the potatoes digested remain unchanged.

An addition of oil (olive, poppy and rape oil) to a diet of hay and straw is also apparently without unfavorable influence on the rate of digestion; indeed some experiments with small quantities of oil (1-2 lb. of oil per day per 1,000 lbs. live weight) show an improved digestion of the dry fodder. With large additions of oil the appetite of the animal for hay and straw is much diminished. Oil supplied in moderate quantities is itself entirely digested.

An addition of starch or sugar to a diet of hay or straw diminishes its digestibility, if the amount added exceeds 10 per cent. of the dry fodder. The albuminoids of the food suffer the greatest loss of digestibility under these circumstances; the fibre also suffers in digestibility if the amount of carbo-hydrate added is considerable. When starch has been added, it is itself completely digested if the albuminoid ratio of the whole food is not less than 1 : 8.*

These facts are of considerable practical importance. Nitrogenous foods, as oil-cake and bean meal, may be given with hay and straw chaff without affecting their digestibility; but foods rich in carbohydrates, as potatoes and mangels, cannot be given in greater proportion than 15 per cent. of the fodder (both reckoned as dry food) without more or less diminishing the digestibility of the latter. This

* In this statement made by Wolff the whole of the nitrogen in the food is reckoned as albuminoid.

decrease in digestibility may, however, be counteracted in great measure by supplying with the potatoes or mangels some nitrogenous food. When this is done the proportion of roots or potatoes may be double that just mentioned without a serious loss of digestibility. Potatoes exercise a greater depressing effect on the digestibility of hay than roots, starch being more potent in this respect than sugar. The cereal grains are rich in starch, but contain also a fair proportion of albuminoids; they may be added to dry fodder without seriously affecting its digestibility, if the albuminoid ratio of the whole food does not fall below 1:8.*

Common salt is well known to be a useful addition to the food of animals. It does not apparently assist digestion, but it increases appetite; and when sodium salts are deficient in the food, it supplies the blood with a necessary constituent. Sodium salts are tolerably abundant in mangels, and small in quantity in hay; they are absent in potatoes, and generally absent in grain of all kinds.

2. *Experiments with Horses.*—In recent experiments conducted by Wolff, the digestive powers of horses and sheep have been accurately compared, the same food having been supplied to each set of animals. The principal results were as follows:

EXPERIMENTS WITH HORSES.

Food.	Proportion of Each Constituent Digested for 100 Supplied.				
	Total Organic Matter.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.
Pasture grass	62.1	68.8	13.4	65.8	57.0
Meadow hay (very good)	51.7	64.3	23.5	56.9	42.6
Meadow hay (ordinary)	46.6	58.4	18.8	51.7	37.3
Lucerne hay	57.9	74.3	3.2	70.2	39.0
Oats	72.0	87.0	78.2	76.6	25.6
Beans	87.4	86.2	8.5	93.4	69.3
Maize	90.9	77.6	63.0	93.9	100.0

* In this statement made by Wolff the whole of the nitrogen in the food is reckoned as albuminoid.

EXPERIMENTS WITH SHEEP.

Food.	Proportion of Each Constituent Digested for 100 Supplied.				
	Total Organic Matter.	Albuminoids.	Fat.	Soluble Carbohydrates.	Fibre.
Pasture grass	75.8	73.3	65.4	75.7	79.5
Meadow hay (very good)	64.7	66.6	54.5	65.6	63.5
Meadow hay (ordinary)	58.7	57.2	44.3	58.7	59.8
Lucerne hay	59.1	72.8	29.7	67.9	43.6
Oats	72.9	85.5	84.8	77.7	26.1
Beans	89.6	87.1	84.2	91.2	78.5
Maize	88.5	78.5	84.6	91.3	61.9

On comparing these figures it is evident that a horse digests meadow grass and hay less perfectly than a sheep, and the difference between them is apparently as great when the food is young grass as when ordinary hay is employed. There is little difference in the proportion of albuminoids assimilated by the two animals, but the divergence becomes very considerable when we come to the carbo-hydrates, fibre and fat. Of the carbo-hydrates the horse digests 7—10 per cent., of the fibre 22 per cent. and of the fat and waxy matter 25—52 per cent. less than the sheep. On the whole, the horse digests about 12 per cent. less of the total organic matter of grass hay than the sheep. With lucerne hay of good quality the digestion by the horse is far better and (save as regards the fat) nearly equals that of the sheep.

The small digestive power of the horse for vegetable fibre is plainly connected with the fact that it is not like the sheep, a ruminant animal, and is thus unprovided with the same means of attacking an insoluble food. In a trial with wheat straw chaff the horse digested 22.5 and the sheep 47.6 per cent. of the total organic matter.

With grain the digestion of the horse is apparently quite equal to that of the sheep. The beans and maize were soaked in water before they were given to the horse. Stress must not be laid on the digestion coefficients found for ingredients of the food present in small quantity, as for instance, the fat and fibre of beans and the fibre of maize.

3. *Experiments with Pigs.*—These have not been so numerous as those with ruminant animals. The following table shows the digestibility ascertained for some of the common pig foods:

EXPERIMENTS WITH PIGS.

Food.	Digested for 100 supplied.				Albuminoid ratio.†
	Total organic matter.	Albuminoids.	Fat.	Soluble carbohydrates.	
*Sour milk	97	96	95	99	1 : 2.3
*Meat flour	92	97	87	.....	1 : 0.4
Pea meal	91	88	58	97	1 : 2.5
Bean meal	84	79	71	91	1 : 2.6
*Barley meal	84	79	70	90	1 : 7.0
Maize meal	91	84	76	94	1 : 8.8
Rye bran	67	66	58	75	.....
Potatoes	94	81	.....	98	1 : 9.2

*The numbers in this case are the result of a single experiment.

†These ratios refer to the part of the food actually digested.

The digestive power of the pig for the foods here mentioned is very considerable, and in cases admitting of comparison appears to be fully equal to that possessed by ruminant animals. Nor is the pig incapable of digesting vegetable fibre, when this is presented in a favorable condition. Two pigs fed on green oats and vetches digested 48.9 per cent. of the fibre supplied. The digestive apparatus of a pig is not, however, adapted for dealing successfully with bulky fodder. Pigs are very capable of digesting animal food.

4. *Experiments with Geese.*—These birds have no power of digesting vegetable fibre; the food apparently passes too quickly through the system for the fibre to be attacked.

Comparative Nutritive Value of Foods.—Having made ourselves acquainted with the composition and degree of digestibility of the ordinary cattle foods, we may now offer some general considerations as to their relative feeding value.

1. *Influence of proportion of Water.*—The feeding value of roots, and of other foods rich in water, is often diminished by the fact that a part of the heat they produce in the body is consumed in raising the

water they supply to the temperature of the animal, and of vaporizing a part of it as perspiration. With sheep the normal proportion of water to dry food is about 2: 1; with cattle from whose skin perspiration is more active, about 4: 1.

A sheep feeding on turnips in winter in the open field, consuming, say, 20 lbs. of roots per day, will receive in its food about 18 lbs. of water of which 14 lbs. is beyond that necessary for nutrition. This 14 lbs. of water has to be raised from near the freezing point to the temperature of the animal body, a rise of at least 60 degrees Fahr. To warm the water to this extent will require the combustion of about 54 grams of carbo-hydrates, reckoned as starch, equal to about 6 per cent. of the total food consumed. The actual waste of food will, however, considerably exceed this, as a part of the extra water will be vaporized as perspiration, and to vaporize 1 lb. of water at the temperature of the animal body requires the combustion of 62 grams of starch. The consumption of an excess of water will also slightly increase the amount of albuminoids oxidized in the animal body, and thus occasion a certain amount of waste of the nitrogenous part of the food.

The economy of supplying sheep on roots or green fodder with dry food in addition is obvious from the facts just stated; by so doing the quantity of water consumed by the animal is diminished, and its proportion in the diet brought more nearly to a normal ratio.

2. *Capacity for producing Heat and Work.*—The only basis on which the nutritive value of foods of different composition can be compared is in respect to their capacity for producing heat. The production of heat and mechanical work is the principal result which food accomplishes in the animal body; the capacity for producing heat also stands in a near relation to the capacity for producing fat. On the other hand, the amount of heat which any food is capable of producing stands in no relation to its power of increasing or renewing the nitrogenous tissues of the body. We may, however, safely assert that the amount of heat generated by the combustion of the digestible constituents of any food will be a fair guide to its nutritive value, when the diet of which it forms a part supplies a sufficient amount of digestible albuminoids, and this will be the case whenever foods are skillfully used.

According to Frankland's actual determinations of the heat-producing power of fat, albumin, and starch, their comparative values in this respect are 100, 47.4, and 43.1. The albumin is here reckoned as minus its equivalent quantity of urea, as this product of the decomposition of albumin is not burned, but excreted by the kidneys. If,

now, we take the proportions of digestible fat, albuminoids, carbohydrates and cellulose, supplied by any food, and multiply them by the heat coefficients just given, the sum of the products will represent the heat-producing capacity of the food when consumed in the animal body. Taking the heat producing capacity of maize, calculated in this manner, as 100, the values found for other foods will be as follows:

COMPARATIVE HEAT-PRODUCING VALUE OF FOODS.

	Ordinary condition.	Perfectly dry.
Maize	100	100
Linseed cake	95	96
Beans	93	96
Barley	85	88
Oats	80	81
Wheat bran	67	69
Meadow hay	59	61
Wheat straw	47	49
Potatoes	30	105
Mangels	13	100

These figures are to be taken only as approximations to the truth; their correctness mainly depends upon the accuracy of the digestion experiments with ruminant animals described in the last section. The figures given for those foods containing amides, and salts of organic acids, are undoubtedly too high. Linseed cake, from the large proportion of fat and albuminoids which it contains, would be expected to occupy a much higher position in the table; its lower rank is due to its imperfect indigestibility. The table on page 301 shows that while 20 per cent. of linseed cake remains undigested, and therefore useless to the animal, only 12 per cent. of maize, and 10 per cent. of beans are thus wasted.

The general resut is to show that the heat and work-producing power of the more perfectly digested food is nearly equal, if we assume the same quantity of dry food to be supplied in each case.

We should gather from these calculations that an equal weight of maize, beans, or linseed cake will have nearly similar feeding value if supplied to an animal receiving a sufficient amount of albuminoids in

its diet, as for example if given to a sheep fed on good meadow or clover hay.

3. *Proportion of Albuminoids to Non-Albuminoids.*—A further point of great importance in determining the value of a food is the proportion between the digestible albuminoids, and the digestible non-nitrogenous constituents: this relation we have already termed the "albuminoid ratio" of the food. In calculating this relation the whole of the non-nitrogenous ingredients of the food are first reduced, as already explained, to their equivalent in starch. Taking the average composition of foods already given, and the digestibility of their constituents shown by the German experiments, the albuminoid ratios will be as under:

PROPORTION OF NITROGENOUS TO NON-NITROGENOUS CONSTITUENTS IN THE DIGESTIBLE PART OF FOOD.

	Total Nitrogen reckoned.	Amides, etc., not reckoned.
Cotton Cake, decorticated	1 : 1.5	.....
Cotton Cake, undecorticated	1 : 1.8	.....
Linseed Cake	1 : 2.3	.....
Beans	1 : 2.4	.....
Peas	1 : 2.9	.....
Wheat Bran	1 : 4.2	1 : 7.0
Oats	1 : 5.5	.....
Barley	1 : 7.6	.....
Maize	1 : 9.0	.....
Clover Hay	1 : 5.9	?
Meadow Hay	1 : 8.0	1 : 12.4
Swedes	1 : 5.9	1 : 13.1
Turnips	1 : 6.2	?
Mangels	1 : 8.0	1 : 31.8
Potatoes	1 : 10.6	1 : 17.7
Wheat Straw	1 : 61.4	?

In the first column the whole of the nitrogen in the food is reckoned as existing as albuminoids; in the second column the true albuminoids only are taken account of. In calculating the second

column it has been assumed that in a digestion experiment the amides and nitrates, being soluble bodies, would be reckoned as "digestible albumin;" the amides have not, however, been reckoned among the non-albuminous constituents, their equivalent in starch not being yet known.

The figures show in a striking manner the wide differences that exist among foods as to the proportion of albuminoids which they supply, the difference being made still more considerable by the recent discovery that a large part of the nitrogen in certain foods exists as amides and not as albuminoids. Mangels now appear as a food very poor in albuminoids, whereas they were formerly supposed to supply a sufficient proportion; and the same is doubtless true of other roots not yet thoroughly examined.

The poverty of a diet of roots and straw chaff in digestible albuminoids is the true reason of the excellent effects produced by the addition of oil-cake or leguminous grain. Oil-cake and beans used under these circumstances have an effect far above their own intrinsic feeding value, as their presence raises the character of the whole diet, and enables the carbo-hydrates of the roots and straw to contribute to the formation of carcass.

It must be recollected that the albuminoid ratio of a food may be different for different animals if their powers of digestion are unequal. Thus the same meadow hay supplied to sheep and horses had for the former an albuminoid ratio of 1 : 9.1, and for the latter a ratio of 1 : 6.7. The horse, as we have seen, digests the nitrogenous constituents of hay nearly as well as the sheep, but fails in digesting the non-nitrogenous constituents. Hay is thus a more nitrogenous food for horses than for sheep.

The proportion of albuminoids most suitable for various diets will come under consideration in the next chapter.

General Conclusions.—We have now run through the principal points which determine the value of food. A little consideration will, however, show that it is impossible to affix a definite feeding value to any food, as its practical effect must depend in great measure on the conditions under which it is employed; more especially on the kind of animal consuming it, and the general character of the diet of which it forms a part. Thus, the value of a bulky food, as hay or straw, is far greater when given to a ruminant animal, than when consumed by a horse or pig. Concentrated, easily digestible foods, as grain and oil-cake, have clearly a value above their composition when added to a poor and bulky food, as straw chaff, or to a watery food like turnips, because they are the means of raising the diet to a point at which an

animal will thrive. On the other hand, roots and green fodder, even when watery and poor in composition, may have a considerable effect when added in moderate proportion to dry food. The highest value is, in short, only obtained from food when it is skillfully employed.

There is, finally, a condition which we can never hope to express by figures, but which has a considerable influence on the effect of any diet; this is flavor. An agreeable flavor stimulates appetite, and probably promotes digestion. This part of the question belongs, however, rather to practice than science.

CHAPTER VIII.

RELATION OF FOOD TO ANIMAL REQUIREMENTS.

The requirements of the Young Animal.—Composition of colostrum and milk—Suitable albuminoid ratio of the food. *The Adult Animal.*—Work, how performed—Maintenance diets—Labor diet. *The Fattening Animal.*—Conditions necessary for increase—Results obtained when fattening oxen, sheep and pigs or ordinary diets—Alterations in consumption of food, and rate of increase, as fattening proceeds—Albuminoid ratios for fattening animals. *Production of Wool.*—Composition of wool—Influence of diet. *Production of Milk.*—Influence of diet on the quantity and quality of milk—Influence on the character of the butter—Albuminoid ratio for milch-cows.

The Young Growing Animal.—The special character of the nutrition of young animals is the rapid formation of nitrogenous tissue and bone, for which purpose an abundant supply of albuminoids and ash constituents in the food is clearly requisite.

The kind of food most appropriate to the wants of a young animal is shown by the consumption of milk. The milk supplied to the young immediately after birth (the colostrum) is of a very concentrated description. During the first week after birth the quantity of the milk greatly increases, and its composition gradually alters from that of colostrum to that of ordinary milk.

In the following table will be found the composition of the colostrum and milk yielded by various farm animals; the numbers given are the mean of many analyses.

COMPOSITION OF COLOSTRUM.

	Water.	Alb'minoids.	Fat.	Sugar.	Ash.	Albuminoid ratio.*
Ewe	73.2	15.4	2.0	8.0	1.4	1 : 0.8
Sow	70.1	15.6	9.5	3.8	0.9	1 : 1.7
Cow	71.7	20.7	3.4	2.5	1.8	1 : 0.5

*In calculating this relation it has been assumed that ten of milk sugar are equivalent to nine of starch.

COMPOSITION OF MILK.

	Water.	Alb'minoids.	Fat.	Sugar.	Ash.	Albuminoid ratio.
Ewe	83.1	5.5	5.5	5.0	0.9	1 : 3.3
Sow	84.6	6.3	4.8	3.4	0.9	1 : 2.3
Goat	85.3	4.1	5.2	4.6	0.8	1 : 4.1
Cow	87.0	4.0	3.7	4.6	0.7	1 : 3.3
Ass	90.0	2.3	1.3	6.0	0.4	1 : 3.7
Mare	90.4	2.0	1.0	6.2	0.4	1 : 4.0

The colostrum is characterized by an especially high percentage of albuminoids. In milk we find a smaller proportion of albuminoids, and a larger proportion of fat and sugar. The solid matter of milk has a very high feeding value, owing to the large proportion of fat and albuminoids present, and its perfect digestibility. If we take, as before, the heat-producing capacity of dry maize at 100, then the heat-producing capacity of dry cow's milk will be 140. Milk also supplies the ash constituents necessary for the formation of bone and tissue; 100 lbs. of cow's milk will supply about 0.20 lb. of phosphoric acid, 0.16 lb. of lime, and 0.17 lb. of potash.

The relation of the nitrogenous to the non-nitrogenous constituents of milk is much higher than in most vegetable foods; the analyses in the table show a relation varying from 1:2.3 to 1:4.1, and the latter proportion is seldom much exceeded in any sample of milk. In supplying very young animals with artificial food the above facts must be borne in mind; the food should clearly be of an easily digestible character, and contain a considerable proportion of albuminoids and fat. Instead of this, foods rich in starch are too often employed. Linseed is perhaps, of ordinary foods, the one most similar to milk in composition.

As the animal grows the quantity of food it requires increases, at the same time a larger proportion of the food is applied to the production of heat and mechanical work; the proportion of nitrogenous matter in the food may therefore gradually be diminished, carbo-hydrates and fat being quite as fit as albuminoids for producing heat and work. Under natural conditions this diminution in the nitrogenous character of the diet soon takes place, the animal daily taking more

and more grass in addition to its mother's milk. The albuminoid ratio* of the diet of rapidly growing animals may vary from 1 : 5 to 1 : 7, the more nitrogenous diet being most suitable for younger animals, or for the production of more rapid increase.

The Adult Animal.—Food, we have already seen, is primarily employed for the renovation of the animal tissues and for the production of heat and mechanical work; by far the greater portion of the food is applied to the latter purposes.

Much of the work performed by an animal is internal, and consists in the muscular movements which produce circulation, respiration and other vital processes; such work is carried on even when the animal is at rest. In man the whole of the blood is pumped through the heart every half minute. The daily work performed by the heart of an average man has been calculated as equal to 150—200 foot-tons; that is to say, the power exerted by the heart would raise one ton to the height of 150—200 feet. The work performed by other organs, and by the muscles when merely maintaining the body in the erect position has not yet been satisfactorily measured.

It was formerly supposed that muscular force was produced by the oxidation of the muscle, and that a diet rich in albuminoids was consequently necessary if hard labor was to be maintained. This idea is now known to be erroneous, it having been shown by repeated experiments that labor does not necessarily increase the production of urea, while it does in every case greatly augment the amount of carbonic acid and water exhaled. Mechanical power is, in fact, produced not by oxidation of the muscle, but of the organic matter in circulation; this organic matter may be indifferently either fat, carbo-hydrates or albuminoids. The animal food thus obtains the power necessary for the performance of work in the same manner as a steam engine, only that in the body food is burned in the place of coal.

When labor is demanded from an under-fed animal, the oxidation taking place in the circulatory system may be in excess of the food supplied and of the fat and carbo-hydrates in circulation; in such a case the albuminoids of the animal body are oxidized, and the excretion of urea becomes increased. A working animal ill-supplied with food will thus suffer seriously in condition.

In the case of an adult animal not increasing in weight and performing a minimum amount of work, as, for instance, a horse or ox in a stable, the quantity of food required is reduced to its smallest limits. An ox of 1,000 pounds live weight, quiet in the stall, will require daily,

* The albuminoid ratios henceforward given will represent, as far as possible, the proportion of true albuminoids present in the food.

according to the German experiments, about 0.5—0.6 pound of digestible albuminoids,* and 7.1—8.4 pounds of digestible non-albuminous food, reckoned as starch, to preserve its condition. With sheep the maintenance diet must be more liberal, as in their case the growth of wool, with its accompanying fat, is always in progress, and is practically independent of the abundance or poverty of the diet. For 1,000 pounds live weight (shorn), sheep fed on meadow hay will require about 0.9 pound of digestible albuminoids and 10.8 pounds of digestible non-albuminous food, or 16—17 pounds dry organic matter per day to preserve their condition. If fed on mangels and straw chaff the quantity of dry organic matter must be raised to 20—25 pounds. In these maintenance diets for adult animals the albuminoid ratio of the food is but 1:14 in the case of the ox, 1:12 in the case of the sheep fed on hay, and the relation is wider still in the case of the sheep fed on straw and mangels. The inferiority of the latter diet is the cause doubtless of the larger amount of food required.

If external work is to be performed, the body weight remaining unaltered, the quantity of food must be considerably increased, and the food must be of such quality that it may be possible to digest a sufficient amount in the required time. A man doing a fair day's work was found to exhale one-third more carbonic acid than when at rest; a man doing such work would clearly require one-third more food to maintain the same condition of body.

If we assume that when food is burned in the body one-fifth of the energy developed may appear as external work, then 1 lb. of digested starch would enable an animal to perform 485 foot-tons of work, 1 lb. of digested albumin 528 foot-tons, and 1 lb. of digested fat 1,127 foot-tons of work.

The recent experience of the use of maize for horses shows that an albuminoid ratio of 1 : 9 is quite sufficient for a labor diet.

The Fattening Animal.—The character of the fattening process has been more thoroughly studied than the nutrition of young and growing animals.

For the body to increase in weight it is clear that the food supplied must be in excess of the quantity demanded for mere renovation of tissue, and for the production of heat and work. When such an excess of food is given, a part of the albuminoids and ash constituents is generally converted into new tissue, while a part of the fat, carbo-hydrates and albuminoids is stored up in the form of fat.

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* These numbers represent true albuminoids and are, therefore, smaller than the German figures.

As only the excess of the food is converted into increase, liberal feeding is, within certain limits, the most economical. If a lamb can be brought by liberal treatment to 150 lbs. live weight at one year old, the amount of food consumed will be far smaller than if two years are occupied in attaining the same weight, for the food required for animal heat and work during the second year is clearly saved.

Economy of food is also promoted by diminishing the demand for heat and work. An animal at rest in a stall will increase in weight far more than an animal taking active exercise on the same diet. In the same way the increase from a given weight of food will be less in winter than in spring or autumn, a far larger proportion of the food being consumed for the production of heat when the animal is living in a cold atmosphere. Hence the economy of feeding animals under cover during winter. If, however, the temperature becomes so high as to considerably increase the perspiration, waste of food again takes place, heat being consumed in the evaporation of water. The temperature most favorable for animal increase is apparently about 60 degrees Fahr. Quietness and freedom from excitement are essential to rapid fattening; the absence of strong light is therefore desirable.

The capacity of an animal for fattening depends much on breed and temperament. A farmer learns to recognize the fattening disposition of an animal from the feel of its skin, etc.

The three animals with which the farmer is chiefly concerned have very different powers of consuming food, and yield different rates of increase. Lawes and Gilbert reckon that, on an average of the whole fattening period, an ox will produce 100 lbs. of live weight from the consumption of 250 lbs. oil-cake, 600 lbs. clover hay, and 3,500 lbs. swedes. Sheep will produce the same increase by the consumption of 250 lbs. oil-cake, 300 lbs. clover hay, and 4,000 lbs. swedes. Pigs will require about 500 lbs. of barley meal to yield a similar result. Taking these data, the rate of food consumption, and of increase yielded, will be as follows:

RESULTS OBTAINED WITH FATTENING ANIMALS PER 100 LBS. LIVE WEIGHT PER WEEK.

	Received by the animal.		Results produced.		
	Total dry food.	Digestible organic matter.	Food consum'd for heat and work.*	Dry manure produced.†	Increase in live weight.
	lbs.	lbs.	lbs.	lbs.	lbs.
Oxen	12.5	8.9	6.86	4.56	1.13
Sheep	16.0	12.3	9.06	5.10	1.76
Pigs	27.0	22.0	12.58	4.51	6.43

RESULTS OBTAINED IN RELATION TO FOOD CONSUMED.

	Increase in live weight.		On 100 lbs of dry food.		
	Per 100 lbs dry food.	Per 100 lbs. digested organic matter.	Consumed for heat and work.*	Dry manure produced.†	Dry increase yielded.
	lbs.	lbs.	lbs.	lbs.	lbs.
Oxen	9.0	12.7	54.9	36.5	6.2
Sheep	11.0	14.3	56.6	31.9	8.0
Pigs	23.8	29 2	46.6	16.7	17.6

* In calculating the amount of food consumed for the production of heat and work, it has been assumed that the fat in the increase has been derived entirely from the fat and carbo-hydrates supplied by the food.

† The manure is exclusive of litter.

It is evident from the upper division of the table that pigs are able to consume far more food in proportion to their weight than either sheep or oxen. This is due to the concentrated and digestible character of the food (barley meal) supplied to a fattening pig, and to the great capacity of this animal for assimilation. The proportion of of stomach is greater in a fat ox or sheep than in a pig, being on 100

lbs. live weight, 3.2 for the ox, 2.5 for the sheep, and 0.7 for the pig. On the other hand, the proportion of the intestines is greater with the pig than with sheep or oxen. Ruminant animals are thus best fitted for dealing with food requiring a prolonged digestion, while the pig excels in the capacity for assimilation.

As a natural result of the larger consumption of food the pig increases in weight much more speedily than either the sheep or ox; but not only is the rate of increase more rapid, the increase yielded by the pig is also far greater in proportion to the food received, as plainly appears from the lower division of the table. The pig, with its very large consumption of food has, in fact, to spend a smaller proportion of it on heat and work, and has thus a large surplus left to store up as increase. Of 100 lbs. digested organic matter, the fattening ox spends about 77 for heat and work, the sheep 74, and the pig 57. The upper division of the table shows, however, that in a given time a pig does convert a much larger amount of food into heat and work than either sheep or ox; this greater consumption probably represents internal work performed in the laying on of increase. The pig, with its rapid feeding, and high rate of increase, is undoubtedly the most economical meat-making machine at the farmer's disposal.

The results given by sheep are seen to lie in nearly every case between those given by oxen and pigs, being however much nearer to the former than to the latter. The German experiments placed the sheep below the ox as an economic producer of increase, instead of above it, as in the Rothamsted statistics just quoted; the difference is probably due to the different breeds of animals experimented with. The influence both of breed, and of the individual character of the animal on the rate of increase whilst fattening is very considerable.

The results relating to manure will be discussed in the next chapter.

We have hitherto looked at the fattening period as a whole; the rates of consumption and of increase are, however, very different in different stages of this period.

As a fattening animal increases in size, the quantity of food it consumes also somewhat increases, the requirements of the body for heat and renovation of tissue becoming greater as its weight and size are increased; the stomach at the same time becomes larger. When the animal becomes very fat, the consumption of food falls off again, the rate of increase at this point being much diminished.

As fattening advances, the daily increase in live weight becomes gradually smaller, and the same amount of food will produce a steadily diminishing amount of increase. This is partly because the increase

during the later stages of fattening is drier, and contains a larger proportion of fat than in the earlier stages of the process. Partly also because the consumption of food for heat and work is increased with the increasing size of the body. More internal work must also be performed to add increase to a large animal than to a small one. These changes in the rates of consumption and increase are seen more strikingly in the case of pigs than with other animals, from the greater rapidity of the fattening process. The following table shows the average results obtained on sixteen pigs fattened at Rothamsted at the same time, the food being 7 lbs. of pea meal per head per week, with an unlimited supply of barley meal. The pigs had an average weight of 135.8 lbs, when put to fatten, at the end of ten weeks their average weight had become 176.3 lbs.

FATTENING PIGS—WEEKLY CONUMPTION OF FOOD AND RATE OF INCREASE.

	Food consumed.		Increase in live weight,		Food producing 100 lbs. of increase.
	Per Head	Per 100 lbs. live weight.	Per Head.	Per 100 lbs. live weight.	
	lbs.	lbs.	lbs.	lbs.	lbs.
First Fortnight.....	60.1	39.7	15.5	10.3	386
Second Fortnight.....	67.5	36.7	17.4	9.4	388
Third Fortnight.....	66.4	30 9	13.2	6.2	502
Fourth Fortnight.....	66.6	27.4	12.9	5.4	511
Fifth Fortnight.....	69.6	26.3	11.3	4.2	618
Whole Period.....	65.9	32.0	14.1	6.8	469

The figures in this table will explain themselves without further comment. The weights of food refer to meal in its natural state, and do not represent dry substance. The irregularities in the progression of the figures are due to the variable appetite and condition of the animals. Animals when first confined, and supplied with fattening food, always increase largely in weight during the first few weeks, after which the rate of increase diminishes to a considerable extent.

The composition of the animal increase accumulated during fattening has been already given on page 291. The proportion of nitrogenous matter in this increase is very small, scarcely more than 7 per cent. For the purpose of fattening we must not, however, provide food containing as low a proportion of albuminoids as is stored up in the in-

crease; the animal body, in fact, requires a constant supply of albuminoids for the renovation as well as for the production of tissue. A diet tolerably rich in albuminoids is also both more digestible, and of greater feeding value, than a diet poor in this constituent.

Wolff recommends a more nitrogenous diet for fattening sheep than for oxen or pigs. The albuminoid ratio he recommends for fattening sheep is 1 : 4—5. For pigs, 1 : 4—5 below 6 months, and 1 : 5—6 above that age. For oxen, 1 : 7 at the commencement of fattening, to be reduced to 1 : 5.5 when fattening in earnest has set in. In all these diets, however, the amides have been reckoned as albuminoids, the error thus occasioned falling chiefly on the diets of the sheep and oxen. If we draw our conclusions from the composition of diets of acknowledged good quality, and regard solely the true albuminoids present, we shall find that a diet having an albuminoid ratio of 1 : 9—10 is very suitable for fattening oxen; a diet of 1 : 8—9 will give good results with sheep, and one of 1 : 7 with pigs. Diets more nitrogenous may, however, be employed with more or less advantage.

Production of Wool.—Wool, besides the moisture and dirt which it naturally contains, is made up of three ingredients—suint, fat and pure wool-hair. The suint is an excretion of the perspiration glands of the skin; it chiefly consists of a compound of potassium with an organic acid containing nitrogen, of which little is known. Suint is soluble in water, and is in great part removed when the sheep are washed before shearing. In the case of Merino sheep the suint may amount to more than one-half the weight of the unwashed fleece; but in the case of ordinary sheep, freely exposed to the weather, the quantity may be 15 per cent., or less. In a washed fleece the fat may vary from more than 30 per cent. to 8 per cent., or less. Short fine wool contains the largest proportion of fat. Pure wool-hair contains about 16 per cent. of nitrogen. The quantity of nitrogen and ash constituents in unwashed wool has been already given on page 290.

The production of wool-hair and of wool-fat is practically no greater when sheep receive a liberal fattening diet, than when the diet only suffices to maintain the ordinary condition of the animal; indeed, under poor treatment, the carcass may lose weight to some extent without the production of wool being seriously altered. With starvation, however, the yield of wool is considerably diminished. If sheep are kept on a poor diet for the mere production of wool, the amount of albuminoids supplied must not fall too low, wool-hair being formed entirely from this part of the food.

Production of Milk.—The quantity of milk produced is largely determined by the individual character of the animal, and on the length of time which has elapsed since birth; the quality of the milk is also affected, though to a less extent, by the same conditions. Subject to these natural limitations, both quantity and quality are greatly influenced by the character of the food supplied.

A liberal diet is essential for a full supply of milk. Green fodder is favorable to a large produce, so also are brewers' grains. The diet of a milking cow should vary with the yield of milk, the object being to obtain as large a yield as can be reached without fattening the animal.

The quality of the milk is considerably influenced by the richness of the diet. A diet of watery grass will probably yield a moderate quantity of pure milk, the addition of oil-cake will increase both the yield of milk and also its richness. The alteration in the composition of milk by poor or liberal feeding is chiefly an alteration in the percentage of solid matter; the relative proportions of casein, butter and sugar, are scarcely affected by the character of the diet.

The quality of the butter is more or less influenced by the character of the food, some foods producing a hard, and others a soft butter. Rape-cake, oats, and wheat bran are reckoned in Denmark as first-class butter foods; palm-nut cake and barley as second class foods; while linseed cake, peas, and rye are placed in the third class. The first-class foods produce a soft butter, the third-class foods a hard butter. By the employment of first and second-class foods with straw chaff, hay and roots, an abundance of excellent butter may be produced throughout the winter. Turnips strongly flavor both milk and butter; mangels are a better food for milk cows.

As milk is a product far more nitrogenous than the increase of carcass obtained when an animal is fattened, cows in full milk will require a tolerably nitrogenous diet. Such a diet is naturally provided when cows feed on young grass and clover; when hay, straw and roots form the bulk of the food, it is imperative that cake or grain be also employed if abundance of milk is desired. Wolff gives 1:5 as the albuminoid ratio most suitable for the diet of cows in full milk; deducting amides, the ratio will probably be about 1:6—7.

CHAPTER IX.

RELATION OF FOOD TO MANURE.

The quantity of manure produced by oxen, sheep and pigs under given diets—Proportion of the ash constituents and nitrogen of the food which appears in the liquid and solid excrements—Composition of the excrements of sheep and oxen—The relative manure value of various cattle foods—The value of the ash constituents and nitrogen of animal manure as compared with the same materials in artificial manures.

The quantity of dry manure produced for a given quantity of food consumed has been already mentioned. The figures in the table on page 318 show that, with the diets assumed, the sheep produces for the same weight of dry food nearly twice as much manure as the pig, while the ox produces even more manure than the sheep. This difference is due to the less digestible character of the food supplied to the sheep and ox. The quantity of manure produced during the same time and for the same body weight is, however, very similar with the three animals, the greater consumption of food by the pig counterbalancing its lower rate of manure production.

The only constituents of food which are of importance as ingredients of manure are the nitrogenous substances and the ash constituents. If the live weight of an animal remains unchanged and there is no production of milk, the quantity of nitrogen and ash constituents voided in the manure will be the same as that contained in the food consumed; the albuminoids and ash constituents of the food used for the renovation of tissue being in this case equivalent to the quantity yielded by the degradation of tissue. In cases where the body weight is increasing or milk is being produced, the amount of nitrogen and ash constituents in the manure will be less than that in the food in direct proportion to the quantity of these substances which has been converted into animal produce.

A part of the albuminoids and ash constituents is left undigested during the passage of the food through the alimentary canal; these are voided in the solid excrement. The digested nitrogenous matter and ash constituents pass into the blood; a part of them may be converted into animal increase if the animal is gaining in weight or pro-

ducing milk, and the remainder is finally separated from the blood by the kidneys and is voided in the form of urine. The albuminoids and amides are oxidized into urea before being expelled from the system. In the case of herbivorous animals hippuric acid is also formed in variable quantities and is found as an ingredient of the urine.

The proportion of the nitrogen in the food which will appear in the solid excrement is determined by the digestion co-efficient of the albuminoids. Thus 79 has been already given as the digestion co-efficient of the albuminoids of barley meal when consumed by a pig; it follows that in this case for 100 of albuminoids consumed 21 will be voided in the solid excrement and 79 pass into the blood. It has been already stated that 500 pounds of barley meal, containing about 53 pounds of albuminoids, will, in the case of the pig, produce 100 pounds of animal increase containing 7.8 pounds of albuminoids. It follows from these data that for 100 pounds of albuminoids consumed, 14.7 are stored up as carcass, 21 appear in the solid excrement and 64.3 as urea, etc., in the urine. In the same way, by deducting the ash constituents stored up from those present in the food, we can arrive at the quantity of ash constituents voided in the manure. Calculating in this manner, the relation of food to manure in the case of the fattening ox, sheep and pig receiving the diets assumed in previous calculations (p. 318), we arrive at the following conclusions:

NITROGEN STORED UP AND VOIDED FOR 100 CONSUMED.

	Stored up as increase.	Voided as solid excrement*	Voided as liquid excrement.	In total excrement.
Oxen	3.9	22.6	73.5	96.1
Sheep	4.3	16.7	79.0	95.7
Pigs	14.7	21 0	64 3	85.3

*The quantities of nitrogen given in this column are a little below the truth, as besides the undigested albuminoids some nitrogenous biliary matter is present in the solid excrement. With oxen and sheep the amount of billiary matter in the excrement is very small; with pigs it is more considerable. In the case of the pig the nitrogen in the solid excrement should probably stand as 25.0, and that in the liquid as 59.3.

ASH CONSTITUENTS STORED UP AND VOIDED FOR 100 CONSUMED.

	Stored up as increase.	Voided in total excrements
Oxen	2.3	97.7
Sheep	3.8	96.2
Pigs	4.5	95.5

The proportion of the nitrogen and ash constituents of the food which is stored up in the body of a fattening animal is in all cases very small. In the case of each animal mentioned in the above tables more than 95 per cent. of the ash constituents of the food find their way into the manure. With oxen and sheep more than 95 per cent. of the nitrogen of the food are likewise thus voided. The pig is seen to retain the largest proportion of the nitrogen of its food; this is clearly owing to the greater proportion of increase which the pig produces for a given weight of food consumed.

The amount of nitrogen voided in the urine is seen to be three or four times the quantity contained in the solid excrement. This relation will vary greatly according to the character of the diet. If the food is nitrogenous, and easily digested, the nitrogen in the urine will greatly preponderate; if, on the other hand, the food is one imperfectly digested, the nitrogen in the solid excrement may form the larger quantity. When ordinary hay is the diet, the nitrogen in the solid excrement will generally somewhat exceed that contained in the urine; with a straw diet the excess in the solid excrement will be much greater. On the other hand, grain and cake, and especially roots, yields a larger excess of nitrogen in the urine.

The ash constituents are very differently distributed in the solid excrement and urine; in the former, the lime, magnesia, and phosphoric acid are chiefly found, while the latter contains nearly all the potash. With sheep fed on hay, about 95 per cent. of the lime contained in the food, 70 per cent. of the magnesia, and 83 per cent. of the phosphoric acid were found in the solid excrement, but only 3 per cent. of the potash.

A fair idea of the general composition of the solid excrement and of the urine, is given by the following table. The sheep were fed on meadow hay; the oxen on clover hay and oat straw, with about 8 lbs. of beans per day.

PERCENTAGE COMPOSITION OF SOLID AND LIQUID EXCREMENT.
SHEEP FED ON HAY.

	Solid excrement		Urine.	
	Fresh.	Dry.	Fresh.	Dry.
Water	66.2	.....	85.7	.....
Organic matter	30.3	89.6	8.7	61.0
Ash	3.5	10.4	5.6	39.0
Nitrogen	0.7	2.0	1.4	9.6

OXEN WITH NITROGENOUS DIET.

	Solid excrement		Urine.	
	Fresh.	Dry.	Fresh.	Dry.
Water	86.3	.....	94.1	.....
Organic matter	12.3	89.7	3.7	63.0
Ash	1.4	10.3	2.2	37.0
Nitrogen	0.3	1.9	1.2	20.6

Both the solid and liquid excrements of the sheep are far drier, and therefore more concentrated, than those of the ox, whose food includes a much larger quantity of water.

The extreme richness of the urine, both in ash constituents and nitrogen, is very evident. In the case of the more highly-fed oxen, the dry matter of the urine is seen to contain over 20 per cent. of nitrogen.

The relative value of the manure produced by different foods is determined by the relative richness of the foods in nitrogen and ash constituents, but chiefly by the amount of nitrogen, this being the most costly ingredient of purchased manure. The average amount of nitrogen, and of the two most important ash constituents contained in ordinary cattle foods, is shown in the following table:

MANURIAL CONSTITUENTS IN 1,000 PARTS OF ORDINARY FOODS.

	Dry matter.	Nitrogen.	Potash.	Phosphoric acid.
Cotton cake (decorticated)	900	66.0	15.0?	31.2
Rape cake	900	48.0	13.2	24.6
Linseed cake	880	45.0	14.7	19.6
Cotton cake (undecorticated)	885	39.0	20.1	22.9
Linseed	905	36.0	12.3	15.4
Palm-kernel meal (English)	930	25.0	5.5	12.2
Beans	855	41.0	12.0	11.6
Peas	857	36.0	9.8	8.8
Malt dust	905	38.0	19.5	17.2
Bran	865	22.0	14.8	32.3
Oats	870	20.6	4.5	6.2
Wheat	856	18.8	5.4	8.0
Barley	860	17.0	4.9	7 3
Maize	886	16.6	3.6	6.1
Clover hay	840	19.7	19.5	5.6
Meadow hay	857	15.5	16.8	3.8
Bean straw	840	10.0	25.9	4.1
Wheat straw	857	4.8	5.8	2.6
Barley straw	850	5.0	9.7	2.0
Oat straw	830	5.0	10.4	2.5
Potatoes	250	3.4	5.6	1.8
Mangels	115	1.9	3.9	0.7
Swedes	107	2.4	2.0	0.6
Carrots	142	1.6	3.2	1.0
Turnips	83	1.8	2.9	0.6

The oil-cakes yield the richest manure, as they contain the largest amount of nitrogen and phosphoric acid, with a considerable amount potash. Next to these come the leguminous seeds, malt-dust and bran. Clover hay yields a richer manure than the cereal grains, while meadow hay stands below them. The cereal grains and the roots contain about the same proportion of nitrogen in their dry substance; the roots, however, supply much more potash. Potatoes stand below roots in manurial value. Straw takes the lowest place as a manure-yielding food; bean and pea straw are more valuable for this purpose than the straw of the cereals.

The ash constituents present in animal manure have probably the full money value of the same constituents in artificial manures, but the nitrogen has on the whole a lower value than the nitrogen of ammonium salts or nitrate of sodium. The nitrogen of the urine is indeed quite as valuable as the nitrogen of ammonium salts. When applied to the soil the nitrogen of urine is rapidly converted into nitrates, the form of nitrogen most suitable for plant nourishment. But, on the

other hand, the nitrogen of the solid excrements is not in a form suitable for plant food, and will be very slowly converted into nitrates in the soil.

Animal manure is probably more immediately available for the use of plants when applied directly to the land, than when previously mixed with a great bulk of litter. Fermentation with litter probably results in the formation of nitrogeous humus compounds, which are insoluble, and decompose but slowly in the soil.

The feeding of animals on the land is a mode of applying manure which has many advantages; but its distribution is irregular, and in autumn or winter the manure is subject to loss by drainage. The most effective plan of application is as liquid manure to growing crops. In winter time the use of litter, and the preparation of farm-yard manure (best under cover), becomes a necessity.

CHAPTER X.

THE DAIRY.

The constituents of milk—The conditions affecting its richness—The fat globules—Modes of raising cream—Composition of cream—Composition of skim-milk—Churning—Composition of butter—Butter-milk—Manufacture of cheese—Composition of cheese—Whey—Necessity for cleanliness.

Milk.—The general composition of colostrum, and of ordinary cow's milk, has already been given on page 313.

The albuminoids of milk embrace two constituents of similar composition, casein and albumin. Casein is coagulated by the additton of acids, or by rennet, but not by boiling. Albumin is not coagulated by rennet, or by most acids, but is coagulated by heat. In colostrum albumin largely preponderates, so that the milk coagulates on boiling; in ordinary cow's milk the albumin forms but one-ninth of the total albuminoids.

The fat of milk chiefly consists of the glycerides of palmitic and oleic acid. The glycerides of stearic, myristic, lauric, capric, capryllic, caproic and butyric acid are also present in small quantity. The last four of these acids are, when in the free state, more or less soluble in water. The glycerides of oleic acid and of the soluble fatty acids, are fluid fats at ordinary temperatures, the remaining fats are solid. The proportion of fluid and solid fats varies somewhat with the diet and condition of the animal; in summer time the proportion of fluid fats is greater than in winter.

The sugar contained in milk is known by chemists as lactose. When milk turns sour the lactose is converted into lactic acid; this acidification of the milk induces the coagulation of the casein, and the milk curdles. The ordinary souring of milk is the work of a ferment, *Bacterium lactis;* when this ferment is excluded no souring takes place.

Cow's milk has generally a specific gravity between 1.028 and 1.032. As the removal of cream raises the specific gravity, which can be brought back to the normal point by the addition of water, no safe conclusion as to the quality of milk can be based on this indication.

The composition of cow's milk is affected by various circumstances; under extreme conditions it may contain from 10 to 16 per cent. of dry matter. The milk is poorer when the quantity produced is large, or the diet insufficient, and richer when these conditions are reversed. A cow is generally in full milk from the second to the seventh week after calving; after this period the milk gradually diminishes in quantity, but increases in richness. A separation of cream takes places in the udder; the milk first drawn is poor in fat, and the richness increases as milking proceeds, the last drawn milk containing two or three times as much fat as the first drawn. The milk of old cows is said to be poorer than the milk of young cows.

The relation of food to the production of milk and butter has already been considered on page 322.

Cream.—The fat of milk occurs in the form of globules; the largest are about .0005 to .0006 inch in diameter, the smallest may be one-tenth this diameter, or even less. The average size of the globules is different with different breeds of cattle. The size appears to diminish as the time from calving increases. The fat globules are in most cases coated with a thin albuminous covering. As the fat globules have a lower specific gravity than the serum in which they float, they tend to rise to the surface, where they form a layer of cream. The largest globules are the first to rise, the smallest never rise at all, being too heavily weighted by their albuminous covering. Milk containing an abundance of large globules is best for butter-making, as the cream then quickly and perfectly rises; but milk with small globules is probably best for cheese-making, as a more even distribution of fat throughout the curd is then obtained.

Milk, when it leaves the cow, will have a temperature of about 90 deg. Fahr.; when set for cream it should be cooled as quickly as possible, as changes in composition would rapidly occur at a high temperature. Milk is usually set for cream in shallow vessels, the depth of milk being perhaps 3 inches; in these vessels the milk stands for thirty-six to forty-eight hours, until the cream has separated. Under these conditions a large surface is exposed to the influence of air, and a maximum amount of change takes place; the result is a decomposition of a part of the albuminoids and fats, the production of lactic acid, and the partial curdling of the milk. The cream obtained in this way is contaminated with curd, and contains various strongly flavored products of decomposition, which deteriorate the quality of the bu ter.

On Swartz's plan the milk is placed in metal pails, 16 inches deep, and surrounded by ice. The cream rises quickly, and can all be ob-

tained in twelve to twety-four hours from the time of setting. Cream thus prepared is perfectly sweet, and free from curd, the low temperature at which the milk has been kept having reduced chemical change to a minimum. It occasionally happens that milk will not yield its cream at low temperatures; this is sometimes the case with the milk of cows several months after calving, and especially when receiving a winter diet.

A third plan of separating cream is by subjecting the milk to extremely rapid horizontal revolutions in a centrifugal machine; under these circumstances the fat globules rise into the center of the revolving mass. In Laval's machine the new milk enters in a continuous stream, and is immediately separated into cream and skim-milk, the former leaving the apparatus by a pipe at the top, the latter by another pipe from the side. The cream thus obtained is, of course, perfectly sweet.

Cream varies considerably in composition. Good cream, not scalded on the Devonshire plan, may contain 55 to 65 per cent. of water, and 25 to 40 per cent. of fat. Casein and the other constituents of milk are present in small quantity. In sweet cream the casein may be about one tenth of the fat; in cream which has soured during setting the casein forms a much larger proportion.

Skim-Milk.—Milk thoroughly skimmed in the ordinary way will contain about 0.8 per cent. of fat; more than this quantity is frequently present. When ice has been used, the percentage of fat left in the milk will be 0.3 to 0.6; and when the centrifugal machine has been employed, 0.2 to 0.5. The two latter processes are thus the most effective for the removal of cream. Ordinary skim-milk will contain about as follows: Water, 90.0; albuminoids, 3.7; fat, 0.8; sugar, 4.8; ash, 0.7. Its specific gravity is generally 1.034 to 1.037. Skim-milk is a very nitrogenous food, the albuminoid ratio being as high as 1 : 1.7.

Butter.—The object of butter-making is to bring about the union of the fat globules which in milk and cream have existed separate from each other. The skilled butter-maker is not, however, satisfied with producing a solid mass of butter-fat; for butter to be of good quality it must possess a certain texture and grain, and be neither hard nor greasy; this desired result can only be attained by churning at a favorable temperature. If the temperature of the cream is too low, the butter will be long in coming, and will be hard in texture. If the temperature is too high the butter will come very speedily, but the product will be greasy, destitute of grain, and deficient in quantity. No temperature can be fixed as the best at which churning should always take place. The proportion of solid and fluid fats in the milk varies some-

what with the diet of the cows, and this necessitates a change in the temperature. A rather higher temperature will be required in winter than in summer; the temperature must also be higher for sour cream than for sweet cream. Generally speaking, perfectly sweet cream should be placed in the churn at 50° to 55° Fahr., and sour cream at 52° to 60°. When sour milk is churned for butter the temperature must be about 65°. The exact temperature most suitable for churning may be ascertained by recording every day the temperature employed, with the length of time occupied in churning, and the amount and character of the produce; when this is done the temperature for each day can be regulated from the experience of the preceding working. The temperature will rise several degrees during churning.

Churning must always be stopped as soon as the butter comes; any over-churning spoils the texture of the butter. The butter is then separated from the buttermilk, washed with cold water, and after standing to solidify is carefully worked and pressed to expel all watery matter; over-working in this stage will also spoil the grain and make the butter greasy. Butter made from perfectly sweet cream keeps far better than butter made from sour cream, as the latter always contains curd, a substance very prone to change. Salt is generally added to improve the keeping quality of butter.

First-class butter will contain about 10 per cent. of water, and not more than 0.5 per cent. of casein, but in ordinary butter these proportions are greatly exceeded. Of the fatty acids in butter about 6 per cent. are soluble in water when separated from the glycerol with which they are combined; this fact serves to distinguish butter from other animal fats in which soluble fatty acids are absent. When butter becomes rancid and glycerides of the fatty acids are partly decomposed, and the fatty acids liberated; the odor and flavor of rancid butter are largely due to free butyric acid.

Buttermilk.—The liquid remaining in the churn after the separation of the butter from the cream has been but little investigated; it must vary a good deal in composition. Danish experiments found that when churning the cream from 100 pounds of new milk .07 to .20 pound of fat was left in the buttermilk.

Cheese.—This substance is prepared by the action of rennet on milk. The rennet solidifies the milk by separating the casein from solution; the fat globules are separated at the same time, being entangled in the curd formed. Rennet is a watery extract prepared from the fourth stomach of the calf; its power of coagulating milk is apparently due to the presence of a ferment, which doubtless plays a similar part

in the ordinary process of digestion in the calf's stomach. The action of rennet is very slow in the case of cold milk, it becomes much more energetic as the temperature rises; at 135° Fahr. it ceases to act. Milk becomes sour when curdled by rennet, but the production of acid (lactic acid) is not essential to the curdling.

The composition of cheese depends principally on that of the milk from which it is made; rich cheese is made from new milk, cream being sometimes added to the milk for the production of the richest sorts; poorer kinds of cheese are made from milk wholly or partially skimmed.

The temperature at which the milk is curdled is of great importance. If the the temperature is low, the curd is very tender and the whey difficult to separate; if, on the other hand, the heat is too great, the curd shrinks too much and becomes hard and dry. A temperature from 74° to 84° is generally employed, the lower temperature for thin cheeses, the higher (80° to 84°) for thick.

When the curd is sufficiently firm it is carefully cut in all directions, and the whey allowed to drain off. To facilitate the drainage of the whey the curd is often heated after cutting, with the view of making it shrink and harden; the temperature used at this point must not exceed 100° Fahr. The drained and broken curd is next put into a press, to remove more effectually the last portions of whey. It is then pulverized in a mill, salted, again passing through the mill, and is then ready for filling into the frames. Curd when put into the frames should contain, according to Vœlcker about 54 per cent. of water when thin cheese is to be made, and not more than 45 per cent. if thick cheese is manufactured. The curd from skim-milk will contain much more water than a curd rich in butter. The frames filled with curd are subjected to a gradually increasing pressure for several days. The cheese is then removed from the frame and placed in the cheese-room to ripen.

Cheese ripens best at a moderately warm temperature; about 70° is a suitable degree of heat. During the operation a loss of water takes place, the loss being greatest in the case of poor cheese. If decay, or a growth of mould occurs, a further considerable loss of weight takes place, the casein and fat of the cheese being decomposed by the organic life thus introduced, while carbonic acid, ammonia, and a variety of other products are formed. It was once believed that fat was produced during the ripening of cheese; this, however is not the case.

A very rich cheese, as old Stilton, may contain about 20 per cent. of water, 44 per cent. of fat, and about 29 per cent. of casein. In a good

Cheddar or Cheshire cheese we should find about 33 per cent. of water, 33 per cent. of fat, 28 per cent. of casein, and about 3 to 4 per cent. of ash constituents, nearly half of which would be common salt. In skim-milk cheeses the percentage of water is greater, and that of fat less. Thus a poor single Gloucester may contain 38 per cent. of water, 22 per cent. of fat, and 31 per cent. of casein. In skim-milk cheese made in Denmark, from milk from which the cream has been very completely removed by the ice system, only 4 to 5 per cent. of fat are present.

Whey.—The whey which drains from the curd in cheese-making is a perfectly transparent liquid, containing the sugar and albumin originally present in the milk; it should not contain more than a trace of butter. If, however, the curd has been roughly treated, the milk has been rich, and the temperature high, larger quanties of butter will be present, and the cheese suffer in consequence. When whey is rich in butter it is generally allowed to stand until the butter has risen; the butter may then be added to the next churning. The average composition of whey is shown by Vœlcker's analyses to be as follows: Water, 93.0; albuminoids, 1.0; fat, 0.3; sugar and lactic acid. 5.0; ash, 0.7. The albuminoid ratio is 1 : 5.2.

In all the operations of the dairy the greatest cleanliness must be observed; all vessels should be washed with hot water as soon as done with, to destroy any adhering ferment. Without such precautions no good butter or cheese can be made.

PRACTICAL BOTANY.

BY PROF. L. R. TAFT.

Read before the Farmers' Meeting held at Columbia, Boone county, Nov. 4-5, 1886.

Even in these days of enlightened agriculture few persons are able to understand the necessity of a scientific education to a man who is to be "only a farmer."

Many will admit, perhaps, that a knowledge of the rudiments of chemistry and geology is desirable to enable us to understand the nature of our soils, to assist us in selecting soils adapted to different crops, and to reveal the methods employed by nature in evolving plant food.

These sciences, useful though they are, are of less importance than some of the others. The chemical force acts for the most part only upon inert and dead matter, and the knowledge of its influence is to the practical farmer of less value than an insight into the working of that mysterious force, life, which is able to transmute the inorganic and mineral elements of the soil and air, into the wonderful vegetable creations which cover the earth and to which the animal world looks for its food.

Just as the early chemists, or alchemists as they were called, bent over their crucibles in search of the elixir of life, so the first botanists ascribed medicinal qualities to every species of plant, and sought them with the hope of obtaining new medicines. The first botanies published in the English language were known as herbals, and were but little more than a list of medicinal plants and their properties.

It is probably owing to this that most people seem to find some coincidence between a bundle of herbs and botany. Many object to the scientific nomenclature and descriptive terms. They forget that Latin is the language of scientific men the world over, and that when a plant is described and named by a botanist in Europe, for instance, the same name will answer in America. As a result of this only a small proportion of our plants have English names.

The use of one universal language thus prevents confusion, while the words are as easily rememered, spelled and pronounced as English names. The idea that the ability to call five hundred or a thousand plants by their Latin names makes a botanist cannot be too vigorously opposed.

The other side is rather too strongly stated in the remark sometimes heard, that a person can be an excellent botanist without knowing the name of a single species. Some persons lay claim to being botanists who have collected and arranged in an herbarium two or three hundred plants. This alone, however, does not make botanists of them. Herbariums or collections of dried plants are of great value for reference, and if, while collecting and preparing the specimens, the powers of observation are used aright, considerable knowledge as to the structure and habits of the plant can be obtained.

One of the principal advantages of the biological over the classical and similar studies is in the abundant opportunities given for perfecting the powers of observation. Says Prof. Lindley: "These subjects train the memory and reasoning faculties, but do not teach the habit of observation." Botany, according to Webster, is the science which treats of the structure of plants; the functions of their parts, their places of growth, their classification and the terms employed in their description and denomination.

Taking this definition of botany, there can be no stronger statements of its value to the farmer than those of Liebig, who says: "The scientific basis of agriculture embraces a knowledge of all the conditions of vegetable life, of the origin of the elements of plants, and of the source from which they derive their nourishment," and of Lindley: "Good agriculture and horticulture are founded upon the laws of vegetable physiology, and no man deserves the name of gardener who is not master of everything known as to the way in which plants feed, breathe, grow, digest and have their being."

Taking this remark as a guide we can easily perceive that for the performance of their functions, plants must have digestive, respiratory and other organs, and careful observation will show us that, although unlike the corresponding parts of animals, they are adapted to the performance of similar functions.

The simplest plants, like the lowest animals, are microscopic in size, and consist of but one cell. They are nothing more than a mass of protoplasm, a substance similar to the white of an egg, enveloped in a thin membrane. As we go higher in the scale of being we find the forms becoming more complex. They consist of many cells arranged in threads and in expansions of various shapes which constitute the

organs of the plants, yet these very plants in the beginning were unicellular, and by a series of divisions and subdivisions of the original cells have attained their full development, thus producing the phenomenon of growth.

Few persons have any idea of the rapidity with which this takes place under favorable circumstances. A puff ball has been known to form 66,000,000 cells per minute, while a squash has by actual measurement been found to develop its roots at the rate of more than 1,000 feet in 24 hours. That the expansive force of growing plants is very great was shown by the squash in the experiment mentioned above, which having been placed in a frame was able by its expansion to raise a weight of 5,000 pounds.

The weak and tender mushrooms are not only able to force their way up through the compact soil, but often raise and support enormous weights.

These wonderful creations feed themselves, with both hands and feet, as it were. They spread out their vast expanse of leaf surface in the air and seize such of its constituents as they desire, while their finely divided feet descend into the earth and bring up a supply both of organic and inorganic food.

That part obtained from the soil is in the form of a solution, and for the perfect development of the plant must contain certain proportions of such mineral elements as potash, lime, magnesia, phosphorus, suphur, etc., in addition to oxygen, hydrogen, nitrogen and carbon, which are also obtained from the air.

These elements are taken up by plants not only in different proportions, but in vastly different quantities in the aggregate. Thus a crop of two and one-half tons of hay per acre will require about 400 pounds, and one ton of tobacco per acre will use up 500 pounds of inorganic matter. While a crop of hemp will take only five pounds per acre, yet assuming that the grass crop feeds only upon the first twelve inches of the soil, and that one foot of soil spread over an acre will weigh 2,000 tons, it will be seen that only 1-10,000 of the soil has been taken off. If this is the case, why do our soils become exhausted or "run out?"

Plants can only make use of food when it is in a soluble condition, and if a field is cropped for a series of years the soluble mineral elements will be used up, unless nature is able to keep up the supply. This she is seldom able to do. The crop becomes less each year, until at length some system of fertilization must be resorted to. The exhaustion, however, is only partial, as experiments have shown that

if proper proportions of potash, phosphorus and nitrogen are supplied the other elements required for a full crop will be developed from the soil.

While the plant is thus drinking in water through its roots, the leaves are giving it off by evaporation. This causes an upward movement of the water from below to take its place.

The leaves of a plant are a most wonderful chemical laboratory. They contain a green coloring matter, known as chlorophyl, which is able under the influence of sun light to decompose carbonic acid and water, and form from them cellulose sugar, and various carbo-hydrates.

Said Dr. Chadbourne, "To accomplish all we wish and all we expect, we must undoubtedly call to our aid the kindred science of chemistry."

All animals, man included, are so constituted that they cannot subsist upon inorganic elements.

We may prove with all the science of a Liebig that charcoal and air and water contain all we need, but we know that they would form poor fare for our tables. We may call in the aid of chemistry with all its power to produce transformation, give it a magazine of the pure elements, and it cannot furnish us with a single grain of starch, nor crystal of sugar.

The plants are the only chemists that can take up these inorganic materials, and in the wonderful laboratory of their living tissues mould them into forms to support animal life. The materials thus organized in the leaves slowly diffuse through the plant and are used to promote its growth and upbuilding.

One of the most important functions of plants is the development of seed for the perpetuation of the species.

In flowering plants the essential organs of reproduction are the stamens and pistils. They are protected in the bud by floral envelopes, and may both be in one flower, or they may be in separate flowers, either on the different parts of the same plant, or on different plants.

The germ cells are formed within the pistil and will not develop until they have been fertilized by the pollen, a yellow or brownish powder produced by the stamens. The pollen is carried to the pistil either by the action of wind, by the aid of insects, or by certain peculiar movements of the essential organs themselves.

Having been fertilized the ovules develop and form the seeds of the plant.

Many of the flowers are so arranged as to be cross fertilized. Some permit the bees covered with pollen to enter without touching the stamens.

The end of the pistil is soon covered with pollen by the bee, and when ready to leave the flower, it is obliged to brush against the stamens and take on a load of pollen to be deposited in the next flower which it enters.

The same result is effected in other flowers whose stamens are not fully developed until several days after the pistil.

The ovules in the meanwhile have been fertilized by pollen from another flower, and thus self-fertilization is prevented.

The squash, cucumber and other plants of the order have their stamens and pistils in different flowers on the same plant, and the pollen is naturally transferred by insects. When these plants are grown in the greenhouse, it seldom happens that the insects are sufficiently abundant to do the work properly. The gardener, in order to get a crop, is obliged to transfer the pollen by means of a brush, or in some similar way.

The effect of cross-fertilization is not noticeable except when different varieties have been crossed. Thus, two corn plants of the same variety growing near together, could cross-fertilize each other, and it could not be detected in the seed; but if a red variety should cross its pollen with a white variety, the exchange would be noticed at once.

It is a disputed point whether the influence of the pollen is confined to the seed or extends to the seed coats and receptacle.

In the case of the fleshy fruits, like the apple and strawberry, the discussion is particularly warm. On one side it is claimed that the flesh of the fruit is influenced by the pollen, both in texture and taste, and that the form and color are also affected.

While some experiments seem to substantiate this view, there is an equal number which oppose it.

Perhaps the strongest witnesses in its favor are the apples, some of which are said to have one side sweet and the other sour, or one-half red and the other russet.

Cross-fertilization can also take place between nearly related species, such as the European wine grape and the various American species. The result is known as a hybrid and the process is called hybridization. It is resorted to for the purpose of increasing their hardiness, vigor, quality of the fruit, or perhaps their ability to withstand disease.

A seed is an embryo plant in a dormant state. If it is exposed to moisture and air under a proper degree of temperature, it will at once start into growth. Water is absorbed, the seed swells, and the oxygen

of the air decomposing the starch stored up in the seed, renders it soluble and it becomes the food of the young plantlet.

The root appears, and at once sinks down into the soil, while the stem rises into the light and air, each prepared to perform its part toward the upbuilding of the plant. We have now briefly noticed the structure and functions of some of the principal organs of plants.

These subjects are included under what is known as Structural and Physiological Botany. The science of botany also covers the place of growth of plants, as Webster puts it.

Few of our common agricultural plants are indigenous here, and they have all been so changed by selection and cultivation that they are hardly recognizable.

Thus the potato and apple were scarcely edible. The turnip and carrot had only stringy, spindle-shaped roots, and the leaves of the cabbage were separate and did not form a head.

Many of them are grown under unnatural conditions and at unusual seasons.

If we can ascertain the geographical distribution of these plants, and know the character of the soil, and of the climate of the countries from which they came, we can vary the treatment to suit the needs of the individual plants.

Thus some plants, as the peach, do best in a light, thoroughly drained soil; the cacti from the dry plains of Western Texas and Arizona are successfully grown only when left unwatered for six months of the year; while the willow and alder seem to take delight when growing with their roots in standing water.

Nearly all plants are subject to the attack of fungi, such as mildews, rusts and smuts. The presence of these parasites is often owing to some unhealthy condition of the plant itself. This might be due to half a dozen different causes. A close observer who is familiar with the nature and requirements of plants, can generally detect the difficulty and suggest a remedy, while a knowledge of the habits of the particular fungus would enable him in many cases to check its ravages.

The facts presented above can be made of practical value in various ways:

First—Knowing that plants are soil robbers, and that they take up the elements of the soil in different proportion and from different layers of the soil, we are able to hinder the rate of exhaustion by practicing a rational system of crop rotation.

Second—If we know the character of the soil best adapted to the perfect development of a plant, we can select accordingly.

Third—We have learned that moisture is required for seed germination. Seeds, then, should be planted at such a depth that during the process of germination they will be in permanent moisture. In some parts of Colorado corn to do well has to be covered twelve inches deep. When the soil is sufficiently moist a depth for ordinary seeds of from about a sixteenth of an inch to two inches, in accordance with the size of the seed, will give the best results.

Fourth—If the subject of cross-fertilization and hybridization is understood many discouraging results caused by mixing of the seed will be prevented.

In these and other ways practical botany or rather a practical knowledge of botany will be of great use to the farmer and horticulturist. Not alone from books is this knowledge obtained. Some persons possessed of sharp eyes and observing habits, who perhaps have never seen the inside of a botany, often know more about the structure and physiology of plants than others who have spent years in the study of botanical text-books.

Our knowledge of the physiology of plants has been greatly increased by the experiments carried on by botanists in different parts of the world. In Europe there are several hundred experiment stations under government control. In this country many States have established such stations, generally in connection with their agricultural colleges. For experimental purposes alone they receive from $5,000 to $10,000 annually, while New York has an independent station which is allowed $20,000. Missouri as a State has done nothing.

A bill has been presented in Congress by Mr. Hatch, of this State, which appropriates $15,000 annually to each State for the maintenance of an experiment station. The object of the station is "to conduct or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of plants at their different stages of growth; the comparative advantages of crop rotation as pursued under a varying series of crops; the capacity of new plants for acclimation, besides a long list of other subjects."

When experiment stations have been established in all of the States and farmers have acquired a knowledge of botany, we shall certainly see an improved system of agriculture.

SCIENTIFIC AGRICULTURE AND HORTICULTURE.

An address prepared for delivery before the Farmers' Institute held at Kirksville, Mo., December 22, 1888, by Geo. D. Purinton, Professor of Biology, University of Missouri.

It is with no ordinary pleasure that I appear before you in the discussion of a topic which should enlist the closest interest of every citizen, the methods by which the great industries of agriculture and horticulture can best be carried on.

These two great branches of industry constitute, have and will ever continue to constitute the very essence and backbone of American industry and American wealth. We are essentially an agrarian people, and we stand among the nations of the earth pre-eminently as agricultural producers, and the production and transportation of our commodities employs the continued effort of more men and means than all other industries combined.

The vast scale upon which our production is carried on makes it clearly apparent that any slight advance in the facility and economy of production would immeasurably increase its aggregate, and yield a corresponding increase in the sum total of our wealth. It is the end of scientific agriculture and horticulture to bring about this advance in the facility and economy of production.

At best the problem of overcoming nature in production is a difficult one, and many a hard battle lies in the producer's way. The earth must literally be subdued before it can minister to the comfort and convenience of mankind. The warfare is one of mind against matter. The wondrous forces in nature must be tamed and yoked fast to the chariot of human progress, or they will continue to be wild and wasteful. No man can become a successful producer unless he possesses intelligence, and he can never become a great producer unless he possess great intelligence, and this can be fully developed only by an earnest and constant study of the principles underlying production. We must know that grain and fruit are the products of plants, and plants in turn are the products of the soil, and the arable soil the pro-

duct of the action of wind and rain and cold and heat upon the rocks whereby they were broken up, altered in chemical properties and rendered soluble in water and suitable for absorption by the growing plant. In order to understand the philosophy of growth we must know, first, the composition of the plant and the fruit it bears; second, from what source it receives its components; and third, the conditions on which it takes and assimilates these inorganic constituents, and continues in a state of health and productiveness.

Let us take an ordinary plant (a stalk of wheat, for instance) and analyze it. We shall find the plant to be composed of fourteen kinds of matter: oxygen, hydrogen, nitrogen, carbon, lime, potash, soda, magnesia, iron, manganese, silica, phosphorus, sulphur and chlorine, and upon experiment we shall find also that all plants gather their substance in varying proportions from some or all of these fourteen elementary bodies. If, then, the plant lives by absorption from the soil and air, it next becomes necessary to know the ingredients of the soil and air and to supply any deficiency in either supporting element.

Experiment has shown that oxygen, carbon, hydrogen and nitrogen are to be found in the air, and that the other ten elements are constituents of the soil. I couple the terms agriculture and horticulture together because they are closely related to each other, indeed we may include both under the generic term agriculture, for the very derivation of this term signifies a general tilling or cultivation of the earth, and the products arising from this cultivation, whether distinctively fruits or vegetables, so called, are agricultural products. The term horticulture, then, as distinguished from agriculture, I will call merely empyrical and nominal. Thus the fruit-producer is clearly an agriculturist, a farmer, and I may add that *every* farmer *ought to be a fruit-grower,* and an *intelligent* fruit-grower. This latter, the intelligence of the agriculturist, is the great desideratum of the science, and the object of the meeting which I now address; and we say that all this trouble and labor is expended in the interest of the one class—the farmer—the producer. In a sense this is true. In a wider sense it is not; for the farmer with the crop he annually harvests is the very substratum of all other branches of business, of all trades and professions. The merchant, the lawyer, the manufacturer, the "bloated monopolist," all are dependent upon him for the very sinues of life. Let the blight or pest fall upon the crop of the yearly tiller of the soil, and the very beams of Wall Street tremble. Great business corporations may fail, earthquaked cities may totter in ruins, and, as usual, the great thoroughfares of our common country continue to pour in the life-blood of public prosperity, but cut short the annual crop of fruit and grain, and the life blood c

commerce stagnates in the public veins, and statesmanship gasps in the arms of a fainting nation. I would say, then, elevate the farmer, increase his intelligence, enlarge his facilities and capacity for husbandry, and you confer a like boon upon every other trade and occupation, for the agriculturist stands at the threshhold of them all. It is lamentably true that while the trades thrive and grow fat in reconverting the products of the soil, a majority of the original producers are, themselves, only "comfortable livers" at best, and too often belong to that numerous class who are scarcely able, despite their most tireless efforts, to keep body and soul together. In farming, as in every other profession, those to whom comes the most marked success, those that tower up above their fellows, are the educated few. I tell you, gentlemen, we must find our really successful farmers and fruit-growers among those who are trained in these pursuits. Classical schools and colleges of liberal arts, the country over, are annually drawing our brightest young men from the country homes into other avenues, and the ranks of the farmers are doomed to be replenished by the dull and uninteresting young men whom fathers, in the parlance of the times, pronounce "incapable of taking an education." And yet capital oppresses labor, and labor marvels and repines at the hardships and privations of her lot. I tell you, the only correction lies in the education of labor. I do not mean by the education of the farmer, the once prevalent idea that an education lay only in the mystic association of musty lore, or the acquisition of exhaustless storers of classical fiction; that will do very well for those who follow the so-called "learned professions," but I submit that it wont do as a method for making farmers and fruit-growers; it wont fill our stock-pens and dairy-yards; it wont turn the ponderous fly-wheels of traffic or of commerce. In this great, teeming, thronging busy world we need that sort of training which is of practical utility in the real affairs of life. Classical education may fill a necessary demand among certain classes of our citizenship, but I submit, that the industrial life of our commonwealth and our nation demands an education that is tangible and practical. We need an education that will fit men for the business of life.

Agricultural education means the application of science to practical agriculture, and until this scientific phase of husbandry shall have been more thoroughly developed, our farmers need not expect to compete with men who have had technical training in other industries. You may continue to raise your apples and corn by a rigid adherence to the crude methods of the fathers, but the factory man and the distiller will as certainly pocket the profits, and grow fat at your expense. You must know the principles of chemistry, botany, zoology, forestry and

veterinary science and their application to the processes of agriculture and stock-breeding, in order to produce your crop intelligently and economically, and keep your place in the line of competition.

The best talent must be kept on the farm and cultivated to its fullest development. It is not surprising that the keenest intellects among the country youth are eager to escape the drudgery of primitive and precarious methods of tilling the soil, and to engage in more pleasing and lucrative employment. Experience has shown that where agriculture has been practiced as a science, the returns from the soil have yielded as great profits as an equal expenditure of capital and effort in other lines of industry can produce. But let us return to a point alluded to in the outset of this discussion, and put the practical test of science to the position I have taken.

Let us take some pure dry sand. It is to all appearance, destitute of the fourteen elements of which I have already spoken, as existing in the earth and air as the component parts of all plants. But it may have absorbed some gaseous bodies from the air. In order to free it perfectly from such possible ingredients that could promote growth, we will heat it to redness and allow it to remain at that temperature for several days, until all volatile bodies must certainly be eliminated. I will now place some of the cooled sand, composed of neither volatile nor seemingly soluble parts, in a suitable vessel, wet it with distilled water, and plant in the wet sand a given weight of corn, wheat or oats. Remember, now, that there is nothing present but the hard, insoluble silica of which the sand is composed, and the pure, distilled water. If the surrounding temperature is suitable for germination, in a few days the grain will sprout, and grow with some vigor. If, when the stalks have attained their maximum growth, they be removed from the sand and weighed, they will be found to have gained five times the original weight of the seed. The addional weight has then come only from the air and the water together with a minute amount of silica that might have been dissolved. That is to say, growth may take place with only four ingredients out of the fourteen previously enumerated, viz.: carbon, hydrogen, oxygen and nitrogen, all gases, and all contained in water and the air, leaving the other ten unemployed. Now, let us vary our experiment. I now take the same weight of seed as in the preceding case, and add pure water to another vessel of sand, but, in addition, I add lime, potash, soda, magnesia, iron, manganese, silica, phosphorus, sulphur, and chlorine, the other ten ingredients that were omitted in the first experiment. When the stalks are grown, as before, I remove and weigh them. The weight has increased seven times its original. This weight may

still be increased by omission of the ten elements, and the addition of some nitrogenous matter, *i. e.*, some body rich in nitrogen, such as dried blood, or cotton-seed meal. Once more I try the experiment, and use both the nitrogenous matter and the water with the ten minerals. The change is now very marked. In the first experiment the stalks were small and produced no grain; in the two succeeding cases there was considerable increase, but in the last the grain is large, well-developed and fully headed—equal to a similar crop in the richest soil. I have learned, then, by a scientific study of the question, that certain bodies are necessary to perfect plant growth and fruitage, and that perfect success in growth is exactly commensurate with the proper application of these bodies. And I might learn by experiment, with equal certainty, the exact ingredients and proper proportions suitable to the growth of all plants. Now, if I have done this, I have learned how I may increase my crop from six to ten per cent.—nearly double—by the judicious use of plant food, or fertilizers. We have now fought the battle with nature, and have triumphed. We have solved the perplexing problem of pushing nature to her utmost. The same principles may be applied to the growth of fruit, and the capacity for production increased two-fold. Again, by experiment we may learn which ingredient is the dominant or leading element in the growth of each plant. Thus, for example, nitrogenous matter is the dominant of wheat.

The inference is that large quantities of nitrogenous matter—stable products, bone meal, or animal and vegetable matter—and but little of the other ten elements, should by used to produce the best results with wheat. When we consider that these ten ingredients exist (with the exception of lime, potash and phosphorus), in abundance in all natural soils, we see at a glance, how simple has become the problem of fertilization. Under this simplified phase of the problem, we have only three elements and nitrogenous matter, instead of ten elements and nitrogenous matter.

Potash is the dominant of the grape. The inference is simple, viz.: Use for grape growing a fertilizer in which potash is in predominance.

The same is true for the potato, the pea, the bean and clover. Phosphoric acid is the dominant of sugar cane and Indian corn. A general fertilizer which has given excellent results consists of:

1.	Super-phosphate of lime	33.34 per cent.
2.	Nitrate of potash	16 66 "
3.	Sulphate of ammonia	20.83 "
4.	Sulphate of lime	29.17 "
	Total	100.00 per cent.

A proper variation of the composition with respect to dominants will render the formula suitable for a large number of special cases.

I cannot close this already lengthy address without speaking of a pest with whose ravages many of our fruit-gowers are unhappily acquainted. I refer to the wooly aphis, better known as the "apple-tree louse" *(Schizoneura lanigera)* It is a small wooly reddish-brown, pear-shaped insect, which is found in two forms, the winged aphis, which attacks the body and branches of the tree, and the wingless insect found under the soil on the roots. This minute object bores through the bark in vast numbers and sucks the sap of the tree, impoverishing the growth, dwarfing the fruit, and finally destroying the tree. The female aphis brings forth its young alive, and produces 100 insects at a single generation. Frequently ten generations occur during the summer, and this gives rise to a total production, during a single season, of more than one quintillion.

This vast system of production must become a terror to apple planters unless some effective remedy can be applied. Washes of kerosene oil, lye, decoction of tobacco, and other substances, have long been used, but with only partial success. A remedy of somewhat recent date and one which is efficient, as well as cheap, and easily obtainable, is called "gas-lime," and consists of the refuse matter of gas works. It is placed above the roots on the loosened soil, in quantities varying with the nature of the soil; loose spongy soils requiring more than heavy clays. In some cases it has, in small quantities, been rubbed on the bared roots and into the angles of the branches, with good results. Care should be used, however, not to use quantities sufficiently large to injure the tree. The aphis is, in all cases, destroyed, with little or no injury to the tree, if proper care has been employed. From five to ten lbs. may be applied above the roots of each tree. Any reliable gas establishment can supply the lime, and I would confidently recommend its use, however damaged the tree may be. Soluble "Pinoleum" also sprayed upon the trees is reported by the U. S. Department

of Agriculture at Washington, as a valuable remedy. The Pinoleum is used in the proportion of fifteen parts of the liquid to eighty-two parts of water.

Permit me to close by emphasizing the importance of industrial education to the great enterprises of the day. The need of special and technical training in all the facts and principles that underlie each particular line of industry, and especially that of agriculture, is so needful and urgent as to require no labored argument in its favor. The vast annual losses to the country from a lack of industrial and economic education are simply beyond all calculation. The wealth that is wasted by ignorant and incompetent farming, the wholesale slaughter on railroads and in machine shops by defective engineering, the destruction from lack of proper ventilation, all pale into utter insignificance before the vast sum total of yearly loss of labor and treasure born of technical incapacity.

You may calculate at least one-half the orchards in the country lost from mismanagement in selecting varieties; count thousands of dollars worth of fine breeds of horses and cattle destroyed by diseases concerning which their owners know absolutely nothing; consider the discomfort and unsightly condition of half the houses in the land; reflect upon the wholesale destruction by injurious insects and plant diseases, before you can feel the urgency of the public demand for entomologists, architects, veterinarians, horticulturists, botanists, and engineers. There is little need of additional farmers and mechanics, but a crying need for better farmers and better mechanics. Nineteen out of every twenty of our population are engaged in some sort of industrial life.

"The great need is for master workmen." These, science alone can furnish. To the farmer a knowledge of the nature of plants, the chemistry of the soil, the habits of insects, the laws of breeding, and the remedies for disease, would not only beautify his life and dignify his labor, but would double his production and his profits.

To the artisan of whatever craft, proficiency attained through long years of special training and practice, "would bear a benign influence and link him to the illustrious few whose tireless labors are clothing the earth with plenty, strength, and beauty." And only when these principles of universal education, and the full cultivation of the transcendent powers of triumphant thinking shall have become universal, shall the wild waste of human effort be stayed, science and labor join hands and rejoice, and burdened humanity meet a just reward.

EXTRACTS FROM AMERICAN EXPERIMENT STATIONS.

The following pages are made up of selection from the reports of various experiment stations of this country. The demand for definite data is rightfully on the increase and happily marks an increased spirit of inquiry on the part of farming.

The material quoted is a condensed statement of some of the experiments that bear most directly on farm methods, and which it is hoped will prove of value for use and reference.

The source of the matter given will be stated at the introduction of each selection, and as the matter quoted is definite and the bearings of each extract clear, no explanatory remarks will be added.

INFLUENCE OF SELECTION OF SEED.

[From report of Horticulturist of New York Agricultural Experiment Station, II. 1883, p. 204—Dr. E. L. Sturtevant, Director.]

In order to ascertain how much may be gained in the earliness of peas by selecting the earliest pods for seed, we gathered last season the earliest and the latest ripening pods from a row of the Tom Thumb pea. One hundred seeds of each of these selections were planted April 21, under the conditions noted for the test of varieties, and a duplicate planting was made May 12. The results were as follows:

Peas from	Planted.	Per cent. vegetated.	Fit for table in — days.	No. of pods per hundred pl'ts.	No. peas per hundred pods.
Earliest pods	April 21	99	68	680	420
Latest pods	April 21	83	74	777	455
Earliest pods	May 12	70	56	2.083	463
Latest pods	May 12	67	60	1,386	311

It thus appears that the earlier ripening peas vegetated better in both cases, the difference amounting in the average to 14½ per cent. They were also fit for the table earlier by an average of five days. The other figures are somewhat confusing. Taking the average of the two plantings, however, we find a difference in favor of the early pods of 2.25 pods per plant, and of .615 peas per pod. This difference was more noticeable while the plants were growing than after they had ripened their crop. Thus, on July 14, we noted that in the planting of April 21 ten plants from the earliest ripened seed had produced sixty-eight pods, of which thirty-eight were well filled, while an equal number of plants from the latest ripened seeds had produced only forty-nine pods, of which but thirteen could be called well filled.

IMPROVEMENT IN SELECTING OATS.

[From New York Agricultural Experiment Station, IV., 1885, pp. 107-108.]

From a quantity of Chinese hulless oats were selected enough small and large plump superior grains to plant an equal area. The large seed made the earliest growth, started the best and presented a better appearance from first to last than did the plants from the small seed. This superiority was manifest in every particular all through the season. After threshing, 10,000 grains of each selection were counted and weighed in individual thousands, with the following result, viz.:

Progeny small seed planted.		Progeny large seed planted.	
1,000 grains weighed	197.52 grains	1,000 grains weighed	211.41 grains
" " "	200.61 "	" " "	212.95 "
" " "	197.52 "	" " "	208.31 "
" " "	199.06 "	" " "	212.95 "
" " "	188.26 "	" " "	211.41 "
" " "	186 72 "	" " "	219.12 "
" " "	188.26 "	" " "	208.31 "
" " "	189.81 "	" " "	206.75 "
" " "	185.18 "	" " "	211.41 "
" " "	188.26 "	" " "	211.41 "
Average	192.09 "	Average	211.40 "

The 10,000 seeds from the selection of small weighed 5.5 ounces, the large 5.06 ounces. Estimating a bushel of hulless oats at fifty pounds it would contain 800 ounces or one bushel of seed as estimated from the small selection, and would contain 266,600 more grains than a bushel of grain grown from large seed. With this difference in the number of grains for one bushel, taking forty bushels for a yield of one acre, it would show a plurality of 10,664,000 small grains—no inconsiderable amount in number, weight or quantity.

INFLUENCE OF SELECTION ON NUMBER OF CELLS IN TOMATO.

[From the New York Agricultural Experiment Station, IV., 1885, p. 185.]

We repeated the experiment made in 1884 of planting seeds of the Early Red Smooth tomato from three-celled and six-celled fruits respectively, with a similar result. Fifty fruits gathered at random from the plants grown from three-celled fruits contained 158 cells, while an equal number from plants grown from six-celled fruits contained 259 cells. As few-celled fruits seem more likely to be smooth than many-celled ones, it is possible that an advantage is to be gained by selecting few-celled fruits for seed.

DEPTH OF PLANTING.

[From New York Agricultural Experiment Station, II., 1883, pp. 138-139—Dr. E. L. Sturtevant, Director.]

On May 18 we planted one row each of Waushakum corn at different depts. Thirty-eight hills in a row, and six kernels in a hill, or 228 kernels in all. The vegetations were as below:

NUMBER FOUND GROWING AT DATES.

Depth.	May 29.	May 31.	June 1.	June 5.	June 22.
One-fourth of an inch	69	139	151	146	130
One inch	53	143	160	175	149
Two inches	1	71	117	160	148
Three inches		15	27	117	135
Four inches		2	2	43	95
Five inches			1	15	91
Six inches			1	4	47
Seven inches			4	11	26
Eight inches			3	9	36

The loss in the plants was mainly occasioned by the heavy rain of June 18. In general, however, our counting of vegetations shows that all the seeds that vegetate do not form plants for crop. The losses come in cases from defective vitality, in cases from insect ravages, but mostly the former; exceptionally, as in our present case, heavy rains wash the soil, and uncover or earth over the young plants.

These rows were harvested October 12, and yielded of ear corn—

Row.	Depth Planted.	Sound Corn.	Soft Corn.
1	1½ inch deep	46 lbs. 1½ ozs.	12 lbs. 6 ozs.
2	1 "	50 " 9 "	12 " 13 "
3	2 "	55 " 14½ "	9 " 9 "
4	3 "	50 " 0 "	8 " 3 "
5	4 "	34 " 2 "	6 " 7 "
6	5 "	39 " 13 "	8 " 11 "
7	6 "	24 " 14½ "	8 " 10½ "
8	7 "	16 " 6½ "	8 " 12 "
9	8 "	15 " 4 "	8 " 7½ "

As the number of stalks varied greatly in the different rows, we will calculate the yield per one hundred stalks in pounds of ear corn—

Row.	Depth Planted.	Sound Corn	Soft Corn.
1	1½ inch	35.4 lbs.	9.5 lbs.
2	1 "	33.5 "	8.6 "
3	2 inches	37.7 "	6.5 "
4	3 "	37.0 "	6.0 "
5	4 "	35.9 "	6.8 "
6	5 "	43.7 "	9.5 "
7	6 "	52.9 "	18.4 "
8	7 "	63.1 "	33.6 "
9	8 "	42.3 "	23.5 "

It is thus seen that the great loss from deeply planting corn came from the loss of plants, and not so much from the unfruitfulness of the plants. It will, however, be noted that where few plants grew these plants had a larger area of soil for occupancy, and better conditions for growth.

[From Bulletin of the Iowa Agricultural College Experiments, 1886, pp. 60-61].

Empire State potato planted with the Aspinwall planter at different depths gave the following results: Two inches deep was as shallow

as the machine would plant. This gave 56 bushels per acre; 3 1-2 inches about the depth at which the regular planting was made produced 74 bushels; 4 3-4 inches, which was the greatest depth possible with this machine, gave 101 bushels per acre. The vines were earlier and stronger where the machine planted the deepest. These plantings were in adjacent rows and were planted May 12. Nature's way for planting the potato is deep and it is, therefore, adapted to coming up from some depth. Examinations show that the long underground stock has many more roots budding out from its sides than the short stems of the shallow planting. Further, there are more underground stems branching out from the main stem when it is farther in the ground and these underground stems bear the potatoes. On mellow arable land great advantage comes from having the potatoes planted four or five inches deep. The deeper plantings were slightly harder to dig because more dirt was necessarily raised.

DISTANCE APART OF TUBERS IN THE ROW.

The Aspinwall planter is so arranged that 8, 6 or 4 droppers or arms may be used, drilling the potatoes 14, 18 and 27 inches apart respectively. Two rows of Dakota Red were planted at each of these distances. The yields were, 14 inches apart 70 bushels per acre, 18 inches apart 58 bushels per acre, and 27 inches apart 40 bushels per acre.

PLANTING AT DIFFERENT DEPTHS AND DATES.

[From Ohio Agr'l. Expt. Sta. V., 1886, pp. 117-119, by Prof. W. R. Lazenby.]

The first planting was done April 28, four plats being planted in corn on this date—one, two, three and four, respectively—the plats planted one and two inches deep were more even in growth than the others, and the stalks had the best color. The best growth of stalks was greatest on the one inch plant, and the second on the two-inch planting; the yield was much greater from the plat of one-inch planting, and the quality of the corn better, there being only 7.7 per cent. of nubbins. The second planting was made May 6, at depths of one to four inches. The different depths caused less variation in the product from this planting. As in the preceding, the largest yield and best development of ears was obtained from planting at one inch in depth. The greatest growth of stalks, however, was from the planting at four inches deep; but the yield from the one-inch plat was nearly as great. A difference of two days in the time of ripening was obtained, the shallow-planted ripening

first. The plats of both dates planted at one inch deep ripened at the same time as did those planted at four inches. These and other facts are clearly shown in Table XI.:

CORN—TABLE XI.—PLANTING AT DIFFERENT DEPTHS AND DATES.

Depth of planting.	Planted April 28, 1886.				Planted May 6, 1886.			
	Yield of corn as weighed from field	Per cent. of ears	Per cent of nubbins	Yield corrected to perfect stand	Yield of corn as weighed from field	Per cent. of ears	Per cent. of nubbins	Yield corrected to perfect stand
	Bushels			Bushels	Bushels			Bushels
One inch	56.0	92.3	7.7	60.6	46.6	84.3	15.7	57.3
Two inches	41.6	74.5	25.5	43.1	38.9	61.5	38.5	39.6
Three inches	25.0	53.2	46.8	29.1	33.8	45.4	45.6	35.5
Four inches	31.1	62.7	37.3	40.6	39.0	77.2	22.8	48.0

Depth of planting.	Yield of stalks per acre	Number of stalks to 100 pounds corn	Date of ripening.	Yield of stalks per acre	Number of stalks to 100 pounds corn	Date of ripening.
	Pounds			Pounds		
One inch	2,013	256	September 7.	1,850	308	September 7.
Two inches	1,981	350	September 7.	1,734	381	September 9.
Three inches	1,486	526	September 7.	1,504	419	September 9.
Four inches	1,492	374	September 9	1,983	315	September 9.

Comparing the yields for four consecutive years, the largest average yield from all depths planted on one date was from the first planting, May 26, an average of 67.8 bushels per acre. In 1884, also, the largest average yield, 44.1 bushels, was from the first planting, May 22.

In 1885 the third planting, May 13, gave the largest average, 82.5 bushels per acre. In 1886 the average for the two plantings was about the same. But the first planting in 1883 was nearly as late as the second in 1884, and nearly two weeks later than the third planting in 1885.

CORN.—TABLE XII.—PLANTING AT DIFFERENT DEPTHS AND DATES. COMPARISON OF FOUR YEARS' TRIALS.

Year.	Average yield of grain of planting at different dates, planted one to three inches deep.					
	First planting.		Second planting.		Third planting.	
	Date.	Yield.	Date.	Yield.	Date.	Yield.
		Bushels.		Bushels.		Bushels.
1883	May 26...	67.8	June 2...	67.4	June 9...	62.6
1884	May 22...	44.1	May 29...	36.5	June 5...	35.4
1885	April 28..	62.4	May 5....	55 0	May 13...	82.5
1886	April 28..	44.3	May 6....	44.1		

Year.	Average yield of grain of planting at different depths, planted on different dates.		
	One inch.	Two inches.	Three inches.
	Bushels.	Bushels.	Bushels.
1883	86.3	60.8	50.7
1884	36.9	37.4	41.6
1885	72.5	64.8	62.5
1886	58.9	41.3	32.3
Average	63.6	51.1	46.8

POTATOES—CUTTING OF SEED.

[From Ohio Agricultural Experiment Station, V., 1886, p. 154.]

As shown in previous reports, the yield is affected largely by the amount of tuber retained in each piece. Large, whole potatoes, when

used for seed, give a greater yield than when cut, and the yield decreases as the size of the piece is diminished. Earliness and vigor are also influenced by the size of the cutting; the former being retarded and the latter diminished in the same ratio that the pieces are decreased in size. These facts have been more fully illustrated the past season by using small potatoes as well as large. The size of the pieces was thus reduced to the very lowest limit. It would seem from this that when one-eye cutting is practiced that large potatoes should be used, so as to give each eye as much nourishment as possible.

Doubtless it is not best in most cases to use whole potatoes for seed, and unless the very best possible preparation of the soil and cultivation are practicable, one-eye cutting is not advisable. Ordinarily, from two to three eyes to the piece will give better results than either extreme. The following table gives the results of last season's work, the series being duplicated throughout:

POTATOES—TABLE IV.—METHODS OF CUTTING.

How Cut.	Total yield, bushels per acre.....	Per cent. of small potatoes.....
Large tubers, planted whole (Early Ohio).....	134.9	65
Large tubers, cut one eye to a piece (Early Ohio).....	57.6	64
Small tubers, planted whole (Early Ohio).....	88.6	50
Small tubers, cut one eye to a piece (Early Ohio).....	36.3	100
Large tubers, cut in two lengthwise (Early Ohio).....	114.4	60
Small tubers, cut in two lengthwise (Early Ohio)...	51.2	36
Large tubers, cut two eyes to a piece (Early Ohio).....	79.1	57
Small tubers, cut two eyes to a piece (Early Ohio).....	88.8	70
Large tubers, planted whole (Early Rose).....	194.3	72
Large tubers, cut one eye to a piece (Early Rose).....	54.3	60
Large tubers, cut two eyes to a piece (Early Rose).....	119.4	59

OBSERVATIONS ON ROOT GROWTH.

ROOT-PRUNING.

[From New York Agricultural Experiment Station II., 1883, p. 133. Dr. E. L. Sturtevant, Director.]

We find no evidence this year favorable to the breaking of the roots of corn in order to influence crop. In order to render the experiment as decisive as possible the operation was carried forward with great severity, the roots being cut just before the heading of the plant by means of a lawn edger forced its whole depth into the ground at two inches from the plant, and on two sides. The effect was quickly seen in the cessation of growth, and the yellowing of the foliage, and the plants did not recover vigorous growth throughout the season. If excessive root-pruning of corn during growth be advisable in some soils, it certainly is not in the clay soil of the Station.

The yields were, for the twentieths acres:

		Sound Corn		Soft	Corn.
6 A	Not root-pruned	227	lbs.	34	lbs.
6 A	Root-pruned	131	"	32	"
D. 11	Not root-pruned	229	"	46	"
D. 12	Root-pruned	157	"	52	"
11 A. 1	Not root-pruned	232	"	25	"
"	Root-pruned	265	"	46	"
11 A. 2	Not root-pruned	232	"	26	"
"	Root-pruned	162	"	36	"
11 A. 3	Not root-pruned	232	"	32	"
"	Root-pruned	142	"	37	"
11 A. 4	Not root-pruned	222	"	33	"
"	Root-pruned	102	"	51	"
11 A. 5	Not root-pruned	217	"	42	"
"	Root-pruned	102	"	49	"

ROOT DEVELOPMENT.

[From Report of Assistant Horticulturist of New York Agricultural Experiment Station Report IV., 1885, pp. 233–239.]

Little attention seems to have been given to the systematic study of the root growth of plants, a question closely related to the study of fertilization and culture. This subject therefore again receives careful attention.

The work of 1884 has been continued into the past season, the results of which we give as follows:

July 16. ORCHARD GRASS (*Dactylis glomerata*).—Fine fibrous roots fill the soil to a depth of one foot. A large number of the roots reached the depth of twenty-one inches. A few were traced to the depth of three feet. Roots were traced horizontally a distance of twenty-one inches when they became so small that they were lost among those of other plants.

TALL MEADOW OAT GRASS (*Avena elatior*).—Fine fibrous roots fill the soil to a depth of twelve inches, many reaching the depth of twenty-one inches. A few were traced to the depth of thirty inches. Roots were traced horizontally a distance of twenty-four inches from the plant.

July 22. KENTUCKY BLUE GRASS (*Poa pratensis*).—Very fine fibrous roots fill the soil to the depth of about twelve inches, many reached the depth of eighteen inches. Some very fine roots were traced to the depth of thirty-seven inches. The roots extended horizontally about twelve inches.

July 23. MEADOW FESCUE GRASS (*Festuca pratensis*).—The soil beneath the plants was filled with fine fibrous roots to the depth of about twelve inches, several were traced to the depth of thirty-two inches. The horizontal roots extended nine inches from the plants.

July 24. RED TOP GRASS (*Agrostis vulgaris*).—The majority of the roots extended almost directly down beneath the plants to the depth of twenty-two inches, a few were traced forty inches below the surface. Horizontal roots extended about nine inches from the plants. The roots were somewhat larger than those of the varieties examined heretofore.

MEDIUM RED CLOVER (*Trifolium pratense*).—Plants grown from seed sown this season. The tap roots extended nearly perpendicularly downward to the depth of thirty-four inches. Branches separated from the tap root throughout its entire length. These were

most numerous between three and twenty-one inches in depth. Some of the branches were traced twelve inches from the tap root.

July 27. BOKHARA CLOVER *(Melilotus alba)*.—The tap root extended nearly perpendicularly downwards to the depth of thirty-three inches. The soil was nearly filled with fibrous roots to the depth of eighteen inches. Branches from the tap root were traced a distance of eighteen inches.

BENT GRASS *(Agrostis canina)*.—Roots extended nearly vertically downwards, nearly filling the soil to the depth of twenty inches, many reaching the depth of twenty-five inches. The larger roots had numerous short branches from one to three inches long. Horizontal roots were traced a distance of twenty-four inches.

July 29. YELLOW TREFOIL *(Medicago lupulina)*.—Plants grown from seed sown this season. The tap root extended to the depth of twenty inches. It began to send out laterals at about three inches below the surface, many of which were traced horizontally a distance of fifteen inches.

WHITE CLOVER *(Trifolium repens)*.—The tap root began to branch at about two inches below the surface. Many of the laterals extended nine inches from the tap root. The majority of the roots were within fifteen inches of the surface. A few were traced to the depth of twenty-four inches.

SHEEP'S FESCUE *(Festuca ovina)*.—Fine fibrous roots nearly fill the soil to a depth of twelve inches; a very few were traced to the depth of twenty-seven inches. The laterals extended about nine inches on each side of the plant.

July 31. ALSIKE CLOVER *(Trifolium hybridum)*.—Plants from seed sown this season. The tap root began branching about two inches below the surface, extending to the depth of 28 inches. The majority of the fibrous roots were between two and twelve inches below the surface. Laterals extended about 9 inches from the tap root.

HASSOCK GRASS *(Airacaespitosa)*.—The most of the fine fibrous roots were within twelve inches of the surface, nearly filling the soil to that depth. Several were traced to the depth of 33 inches. Many laterals extended horizontally a distance of 15 inches.

REED CANARY GRASS *(Phalaris arundinacea)*.—Soil well filled with fine fibrous roots to the depth of 15 inches, many reaching to the depth of 25 inches. A few were traced to the depth of 33 inches. Laterals extended about 15 inches from the plant. There was a thickened underground stem just beneath the surface.

TIMOTHY GRASS *(Phleum pratense)*.—Fine fibrous roots occupied the soil to the depth of 15 inches; several were traced to the depth of

34 inches. The laterals were traced horizontally a distance of 12 inches when they become so delicate that they were impossible to follow.

CUCUMBER.—For the purpose of noting the effect of fertilization upon the root growth of the cucumber, two short rows of the White Spine variety were planted in very fertile garden soil as follows: Row No. 1 was planted over a trench containing six inches of well rotted compost, covered with six inches of soil. Row No. 2 was planted without manure. The rows were cultivated as nearly alike as possible.

Aug. 4. Row No. 1.—The tap root extended downwards nearly perpendicularly until it nearly reached the manure, when it turned to one side until it reached beyond the manure when it again took a downward direction until it reached the depth of 24 inches. Fine fibrous roots extended from the tap root into the manure, completely filling it with a mass of very fine white rootlets. None of the large roots extended into the manure. The laterals were mostly about six inches below the surface, with numerous fibrous roots reaching to the depth of 12 inches from the surface. Many laterals extended a distance of 28 inches from the plant.

Row No. 2.—The tap root extended nearly perpendicularly to the depth of 18 inches, when it became to delicate too trace. The larger roots were smaller than those of Row No. 1, but were more numerous, many extending 48 inches horizontally. The fibrous roots were larger and not so numerous, nearly filling the soil to the depth of 12 inches. The roots extended horizontally as far as the vines reached.

From this it appears that the fibrous roots having an abundance of plant food near by, were more concentrated. Those in Row No. 2 extended to a greater distance in search of food. The tap root did not extend deeply into the soil in search of food. Its function perhaps was to supply moisture to dissolve the plant food contained in the manure and render it available. This question can, however, only be answered by further experiment.

Two rows each of White Star potatoes, Top Over corn and Long Red Mangel Wurtzel were planted May 23 for the purpose of noting the effect of root pruning upon the growth of the roots. The roots were pruned July 16 by placing a six inch board alongside of the row close to the plants and cutting to the depth of twelve inches with a spade along the outer edge of the board.

Aug. 4. WHITE STAR POTATO, root pruned.—Small fibrous roots had started where the roots had been cut off. The majority of the roots occupied the soil between two to eight inches deep. A few roots

extended to the depth of 19 inches. Horizontally, roots were traced a distance of 30 inches from the plant.

WHITE STAR POTATO, not root pruned.—The roots extended about the same distances each way as in the former. There were more underground stems, the tubers were more numerous but smaller. There were seven tubers on this plant, and only two on the former. The two tubers were nearly equal in bulk to the seven.

Oct. 19. WHITE STAR POTATO, not root pruned.—Roots extended to the depth of 17 inches. Laterals extended 26 inches on each side of the plant. Most of the roots were within 14 inches of the surface.

WHITE STAR POTATO, root pruned.—The roots extended laterally only about 12 inches. The majority of the roots were within 18 inches of the surface, numerous roots extended to the depth of 33 inches.

TOP OVER CORN, Row No. 1, July 3.—The soil on each side of the row was thoroughly pulverized to the depth of 12 inches. Row No. 2 was cultivated with the hand hoe sufficiently to keep down the weeds.

July 16, Row No. 1.—The majority of the roots filled the soil to the depth of 9 inches. A few reached the depth of 16 inches. The soil on each side of the plant was filled with fibrous roots for a distance of 12 inches, many of them extending a distance of 3 feet from the plant.

Row No. 2.—The majority of the roots were within 12 inches of the surface. A few were traced to the depth of 27 inches. Laterals extended about 12 inches on each side of the plant.

Oct. 17. Row No. 1.—Corn fully matured. The roots filled the soil to the depth of 24 inches also on each side of the plant the same distance. Several roots were traced to the depth of 34 inches. Laterals extended horizontally three feet from the plant. There were numerous fibrous roots the entire length of the laterals that grew upward to the surface.

Row No. 2.—The majority of the roots reached the depth of 17 inches. A few were traced to the depth of 30 inches. Numerous laterals extended 45 inches from the plants on each side.

Oct. 19. LONG RED MANGEL WURTZEL.—The majority of the fibrous roots reached the depth of 16 inches. Many of them extended horizonally 39 inches from the plant, nearly filling the soil with fine fibrous roots to the depth of 8 inches from the surface. The tap roots were traced to the depth of 26 inches. Numerous roots about the size of a wheat straw extended horizontally from the tap root about 8 inches below the surface.

LONG RED MANGEL WURTZEL, root pruned.—The tap roots ex-

tended to the depth of 26 inches. Laterals extended horizontally about 46 inches. There appeared to be but little difference in the root growth of this and the plant not root pruned, owing perhaps to the fact that the roots had not extended laterally sufficiently to have been cut off by the spade.

CARROTS AND PARSNIPS.—Carrot and parsnip seeds were planted in four-inch drain tiles so as to prevent the formation of all except vertical roots.

Carrots grown in a four-inch drain tile 14 inches long, the tap root after reaching below the tile sent out several roots from which the fibrous ones grew upward to the surface. The tap root extended deeper into the soil.

Parsnip grown in two lengths of four-inch drain tile, the tap root extended the entire length of the tiles, sending several roots between the tiles where they joined together. Fine fibrous roots extended from these both upward toward the surface and also downward into the subsoil. Roots also grew from below the second length of the tile upward toward the surface. The parsnip measured 30 inches in length and about 1 1-2 inches in diameter, being of a uniform size its entire length.

TOBACCO.—To observe the effect of manure upon the root growth of tobacco, two plats were prepared in the following manner: Plat G, 16, was covered with stable manure. The manure was spaded in to the depth of 8 inches. After setting the plants the surface was mulched with hay.

Plat G, 17, had the surface mulched with stable manure after setting the plants.

Sept. 19. Plat G, 16.—Roots extended nearly perpendicularly downward to the depth of 24 inches. Roots extended horizontally about the same distance. The majority of the fibrous roots were within 10 inches of the surface, very few extending below 12 inches. Roots of the size of a lead pencil were numerous.

Plat G, 17.—Roots extended to the depth of 20 inches. Many of the roots extended horizontally a distance of 30 inches. The fine fibrous roots were mostly near the surface. The larger roots were not as numerous as in the former plat.

NOTES BY THE DIRECTOR.

In roots which penetrate the soil it is only the youngest parts with their delicate root hairs and papillæ that absorb nutriment for the use of the plant. The rate of growth of these roots is probably largely

influenced by temperature and moisture, and hence we should anticipate a non-accordance of observations made during different seasons, or in different climates. Thome, in his botany, notes that the roots of a maize seedling attained their maximum rate of growth at 81° F.; those of the pea, wheat and barley, at 75° F.

I find in my notes the following particulars, which may supplement the observations made at the Station.

BARLEY.—Messrs. Lawes & Gilbert record that the roots extend between 4 and 5 feet. Prof. Beal says the combined length of all the roots of a stem of barley in good soil has been estimated at 128 feet and in poor soil at 80 feet.

BEET.—Walkhoff writes that he has traced the roots as much as 4 feet down, where they entered drain pipes, and quotes Schacht as stating that the fibers of the sugar beet penetrate as much as 8 or 10 feet of the soil, and as being found in drain pipes at the depth of 5 feet.

CLOVER.—Atwater found clover roots in Maine to extend 3 feet 2 inches deep in a very heavy clay soil, the surface soil being 3 1-2 inches deep. Hon. Geo. Geddes, in New York, sent to the State Agricultural Society a root 4 feet 2 inches long. Lawes & Gilbert describe *Trifolium pratense,* the red clover, as a very deeply rooting plant with numerous, long, thick, tap-shaped roots, more or less branched and with rather thick wavy fibers, provided with nodules, but almost destitute of root hairs—*T. repens*, the white clover, as possessing a long, deeply penetrating tap-root, giving off numerous rather thick, wiry, flexuous branches, studded with little tubercles and descending obliquely into the soil. Liebig states that clover roots extend 6 feet into the soil.

GRASSES.

DOWNY OAT GRASS (*Avena pubescens*), according to Lawes & Gilbert, has short, creeping, underground root-stocks, and fine thread like roots, generally superficial, but having the power to descend to a great depth under favorable circumstances.

KENTUCKY BLUE GRASS (*Poa pratensis*), has, according to Lawes & Gilbert, underground stems which give off roots which, as well as those from the stolons are fibrous, intricately branched, and penetrating very deeply, but forming a dense mat beneath the surface. The form known as June grass, has roots which in New England, I have traced to 7 feet deep, there being many at 2 and 3 feet.

MEADOW FESCUE (*Festuca pratensis*), according to Lawes & Gilbert, has a subterranean stock, perennial, somewhat creeping, but rarely

producing offsets. The root fibres penetrate more deeply than do those of *F. ovina*, but are not so much branched.

MEADOW SOFT GRASS, (*Holcus lanatus*), according to Lawes & Gilbert the roots do notpenetrate deeply, but form a dense mat just beneath the surface.

MEADOW FOXTAIL, *Alopecurus pratensis*, according to Lawes & Gilbert, has a long deeply penetrating more or less vertical subterranean root-stock, from which proceed creeping offsets or stolons capable of giving off fibrils. In addition to the main vertical root fibres, there is usually close beneath the surface, a dense leash of horizontal fibrils.

ORCHARD GRASS, (*Dactylis glomerata*,) according to Lawes & Gilbert, has strong stout fibrous roots, descending more or less vertically to a considerable depth, and together with other more horizontally disposed fibres matting the soil into a dense ball. The root-hairs, under favorable circumstances, are numerous, long and delicate.

PERENNIAL RYE GRASS, (*Lolium perenne*), according to Lawes & Gilbert, has much branched fibrous roots, which penetrate to a considerable depth and give off a dense network of root-fibrils near the surface. The root-hairs are stoutish, sometimes short, numerous; at other times very fine and intricate.

TIMOTHY, (*Phleum pratense*), according to Atwater, has roots which in Maine were traced 2 feet 4 inches deep, the depth of surface soil being 1 foot 5 inches.

RED TOP, (*Agrostis vulgaris*), according to Lawes & Gilbert, has exceedingly fine much branched roots, which descend to a depth of 4 or 5 feet, and also form a mat just beneath the surface. The root hairs are very abundant in dampsituations, forming a dense white cobweb-like mass.

ROUGH STALKED MEADOW GRASS, (*Poa trivialis*), according to Lawes & Gilbert, has closely matted minute fibrous roots, not penetrating deeply, but forming a dense mat beneath the surface, producing no underground offshoots, but developing, especially in moist weather, creeping branches from the base of the culms.

SHEEP'S FESCUE, (*Festuca ovina*), according to Lawes & Gilbert, is often provided with numerous fine creeping underground stolons. The root fibres are very numerous, fine, with but few hairs, branching in all directions and forming a very dense network just beneath the surface, thereby obtaining full possession of the soil to a depth of from 6 to 10 inches, but not usually penetrating more deeply.

SOFT BROME GRASS, (*Bromus mollis*), according to Lawes & Gilbert, has stiff wiry roots not much branched, but sometimes very deeply

penetrating, as they were traced on one occasion to a depth of 4 to 5 feet, having lost their wiriness and become fleshy.

SWEET SCENTED VERNAL GRASS, (*Anthoxanthemum odoratum*), according to Lawes & Gilbert, has fine much branched, dense root fibres, forming a dense mat close to the surface, but not deeply penetr.. ting.

YELLOW OAT GRASS, (*Avena flavescens*,) has branched fibrous roots that do not penetrate very deeply into the ground.

LUCERNE. According to Gould, the roots will penetrate 15 feet, and Liebig says in some cases it will grow roots 30 feet.

LUPINE. According to Liebig, the roots extend about 7 feet in length.

OATS. The combined length of the roots of oats are stated by Professor Beal at 150 feet.

ONION. According to Gould, onion roots will run down to 3 feet.

PARSNIP. Mr. Mechi gives an instance of a parsnip root extending 13 feet 6 inches downward and the tip was evidently broken off.

RAPE. According to Liebig, has roots of about 5 feet.

SQUASH. The roots of the squash experimented with by Pres. Clark, were estimated at a total length for the plant at certainly more than 80,000 feet.

WHEAT. Mr. Mechi says wheat roots occupy the subsoil to the depth of 4 or 5 feet.

WHEAT ALTERNATED WITH FALLOW AND WHEAT GROWN CONTINUOUSLY.

[From memoranda of the origin, plan and results of the field and other experiments by Sir John B. Lawes, LL. D., F. R. S., Rothamsted, England.]

The results given in the following table show the produce of wheat obtained on the Rothamsted soil for many years in succession, after bare fallow, compared with that of wheat grown continuously year after year on the same land without the intervention of fallow; in both cases without manure.

Hoos-field, in which the experiments on alternate wheat and fallow are conducted, adjoins *Broadbalk-field*, in which wheat has now been grown continuously without, or with different descriptions of manure, for 44 years in succession; and the produce of the unmanured plat of

that field is compared with that grown in alternation with fallow, also without manure, in Hoos-field.

During the first, or preliminary period of 5 years, 1850-1 to 1854-5, the cropping of the acre set apart for the experiment on wheat alternated with fallow, was as follows:—1851, fallow (after wheat in 1850); 1852, wheat; 1853, fallow; 1854, wheat; 1855, half fallow and half wheat. From that time to the present the two halves have been alternately fallow and wheat, giving therefore a crop of wheat succeeding fallow, on half the acre each year. In the upper division of the table is given the *total* produce over the preliminary period of 5 years, over each succeeding 5 years, and over the total period of 30 years, 1856–1885 inclusive; in the middle division the *average* produce per annum over each of the same periods is given; and in the bottom division there is given the produce of the last season, 1886. In the first column of each vertical division of the table, is given the produce *per acre*, on the half acre of wheat after fallow; in the second column, half the amount, that is, the actual produce of the half acre, to compare with the produce per acre (given in the third column) obtained in the adjoining (Broadbalk) field, where wheat is grown year after year on the same land. Lastly, in the fourth column of each vertical division, is given the amount of produce on the land continuously cropped (in Broadbalk Field), more (+) or less (—) than that obtained in Hoos-field, where half the land is under fallow, and half under wheat each year.

(Area under experiment, 1 acre.)

Years.	Dressed grain. (Bushels.)				Weight per bu.		Total grain. (lbs.)				Straw.				Total produce. (lbs.)			
	After fallow.		Grown continuously.		After fallow	Grown continuously	After fallow.		Grown continuously.		After fallow.		Grown continuously.		After fallow.		Grown continuously.	
	Produce	Half produce.	Produce	Plus or minus "Half Produce" after fallow			Produce	Half produce.	Produce	Plus or minus "Half Produce" after fallow	Produce	Half produce.	Produce	Plus or minus "Half Produce" after fallow	Produce	Half produce.	Produce	Plus or minus "Half Produce" after fallow
Total, Per Acre over each Period.																		
5 yrs. 1851–'55	96⅜		73⅝	—22¾			5,877		4,733	—1,144	11,213		8,561	—2,652	17,090		13,294	—3,796
5 yrs 1856–'60	131½	65¾	83⅝	*17¼			7,990	3,995	5,058	*10,063	12,568	6,284	8,439	*2,155	20,558	10,279	13,497	*3,218
5 yrs. 1861–'65	129¼	64⅝	74⅜	9¾			8,041	4,021	4,765	744	12,162	6,081	6,950	869	20,203	10,102	11,715	1,613
5 yrs. 1866–'70	73	36½	66¾	30¼			4,681	2 341	4,167	1,826	6,971	3,485	5,611	2,126	11,652	5,826	9,778	3,952
5 yrs. 1871–'75	62¾	31⅜	51¼	20¼			3,929	1,964	3,282	1,318	7,194	3,597	5,152	1,555	11,123	5,561	8,434	2,873
5 yrs. 1876–'80	61	30½	45¼	14¾			3,771	1,885	2,838	953	5,746	2,873	4,383	1,510	9.517	4,758	7,221	2,463
5 yrs. 1881–'85	85⅜	42⅝	67¼	25⅛			5,218	2,609	4,163	1,554	6,639	3,320	5,289	1,969	11,857	5,929	9,452	3,523
30 yrs. 1856–'85	543⅛	271½	389¾	118¼			33,630	16,815	24,273	7,458	51,280	25,640	35,824	10,184	84,910	42,455	60,097	17,642
Average, Per Acre, Per Annum, over each Period.																		
5 yrs. 1851–'55	19¼		14⅝	—4½	55.8	56.7	1,175		947	—228	2,243		1,712	—531	3,418		2,659	—759
5 yrs. 1856–'60	26⅜	13⅛	16¾	*3½	57.8	55.6	1,598	799	1,012	*213	2,514	1,257	1,688	*431	4,112	2,056	2,700	*644
5 yrs. 1861–'65	25⅝	13	14⅘	1⅘	59.3	60.1	1,608	804	953	149	2,433	1,216	1,390	174	4,041	2,020	2,343	323

5 yrs. 1866-'70.....	14⅛	7⅛	13⅛	6	60.6	59.3	936	468	834	366	1,394	697	1,122	425	2,330	1,165	1,956	791
5 yrs. 1871-'75.....	12⅜	6⅛	10⅜	4⅛	55.2	57.8	786	393	656	263	1,439	719	1,031	312	2.225	1,112	1,687	575
5 yrs. 1876-'80.....	12⅜	6⅛	9⅜	2⅛	58.3	57.3	754	377	567	190	1,149	575	877	302	1,903	952	1,444	492
5 yrs. 1881 '85.....	17⅜	8½	13½	5	58.5	59.3	1,044	522	833	311	1,328	664	1,058	394	2 372	1,186	1,891	705
30 yrs. 1856-'85.....	18⅛	9	13	4	58.3	58.2	1,121	560	809	249	1,709	855	1,194	339	2,830	1,415	2,003	588

PER ACRE, PER ANNUM, SUCCEEDING YEARS.

1886.....	9¼	4⅝	9	4⅛	62.2	61.5	588	294	564	270	657	328	570	242	1,245	622	1,154	512

* All columns designated by * are to be read plus.

DEEP AND SHALLOW CULTURE CONTRASTED.

[From Bulletin No. 6—Second series, Alabama Agricultural Experiment Station, 1886, J. S. Newman, Director.]

OBJECT.—To contrast the effects of deep and shallow cultivation of cotton.

By reference to experiment VIII. it will be seen that in 1884, this inquiry developed the fact that a loss of 85 lbs. of seed cotton resulted from one deep plowing during the cultivation of the crop. The results of the same inquiry made last season show even a greater loss from such root-pruning cultivation on the same land.

The plats were 300 feet long and 14 feet wide, four rows to the plat. The land was very uniform in fertility. Both plats were prepared, fertilized and planted in exactly the same manner. The only difference in the treatment of the plats throughout, was in the plowing given when the stalks of cotton were generally one foot in height, when one plat was plowed with a scooter and small scrape deep enough to break the lateral roots of the plants, while the other was cultivated throughout with heel scrape set to run not deeper than one inch at any plowing. The results are very suggestive to those who practice deep cultivation, especially since they corroborate those of the previous year.

Plat No.	Fertilizers.	Cultivation.	Lbs. Yield Per Acre.
1	500 pounds compost per acre.....	Shallow.	1,102.4
2	500 " " " "	Deep.	993.2
	Loss per acre by deep cultivation.....	.....	109.2

SUBSOILING.

[From Experiments by Prof. E. M. Shelton, Kansas Agricultural College, Manhattan, 1885, page 42.]

The subsoiling—always costly work—was of no advantage to the growing crop in this trial. The slightly diminished yield of the subsoiled plats as compared with the flanking—adjacent—ones, which were simply plowed, is due to the slight variations in the soil of the plats, or, perhaps, to slight differences in the treatment given them, and

not to any unfavorable influence of subsoiling. All this is strictly in line with the results obtained in the course of three years of previous experimental work, and a considerable general experience had at various times upon the College Farm. We have tried subsoiling during these years upon clay lands of almost every degree of fertility; upon lands that had been in cultivation a considerable number of years and with comparatively new lands; but in no case was there any considerable increase in the yield of the subsoiled plats, certainly none at all commensurate with the cost of subsoiling. All this is plainly shown by the subjoined table, which gives in compact form the results of our subsoiling of corn ground during four years:

Four Years of Subsoiling Corn Ground.		Yield per acre, corn, bushels.	Yield per acre, stalks, tons.
1882..	Subsoiled plats	40	—
	Plowed plats adjacent subsoil plats	38	—
1883..	Subsoiled plats	51	1.48
	Plowed plats adjacent subsoil plats	54	1.66
1884..	Subsoil plats	64	1.77
	Plowed plats adjacent subsoil plats	62	1.42
1885..	Subsoil plats	65	1.95
	Plowed plats adjacent subsoil plats	67	2.06
Average yield of subsoiled plats, 4 years		55	1.73
Average yield of plowed plats adjacent subsoil plats, 4 years		55.25	1.71

INFLUENCE OF DRAINAGE.

[From Bulletin No. 7, Alabama Agricultural Experiment Station—J. S. Newman, Director, 1887.]

RESULTS.

Plat Number.....	Fertilizers per acre.	Undrained.			Plat Number.....	Drained.			Increase per acre from drainage.....
		Bushels good corn per acre.	Bushels nubbins per acre.....	Total yield per acre.....		Bushels good corn per acre.	Bushels nubbins per acre.....	Total yield per acre.....	
1	200 lbs. acid phos.....	25.70	2.42	28.12	1	33.48	2.70	36.18	8.06
2	200 lbs. acid phos..... 200 lbs. cotton seed meal...	28.93	.90	29.80	2	42.40	.95	43.35	13.55
3	200 lbs. acid phos..... 200 lbs. cotton seed meal... 200 lbs. kainite.....	28.12	2.42	30.54	3	35.70	1.77	37.44	6.86
4	200 lbs. acid phos..... 200 lbs. kainite.....	27.15	.80	27.95	4	37.05	.48	37.83	9.98
5	200 lbs. acid phos..... 100 lbs. muriate potash.....	24.60	3.21	27.81	5	35.70	1.34	37.04	9.23
6	200 lbs. kainite.....	24.63	.80	25.43	6	33.48	3.12	36.60	11.17
7	100 lbs. muriate potash.....	20.09	.80	20.89	7	37.05	2.23	39.28	18.39
8	Without manure.....	24.11	1.60	25.71	8	34.36	2.23	36.59	10.88
9	200 lbs. cotton seed meal	19.30	.80	20.10	9	36.60	3.56	40 16	20.06
10	200 lbs. gossypium phos.....	24.11	.80	24.91	10	31.69	1.34	33.03	8.12
11	200 lbs. cotton seed meal... 200 lbs. kainite.....	20.09	.80	20.89	11	29.08	3.12	32.20	11.31
12	180 lbs. gossypium phos ... 100 lbs. sulphate ammonia..	17.74	1.65	19.39	12	34.82	2.67	37.49	18.10
13	180 lbs. gossypium phos.... 100 lbs. muriate potash.....	16.85	.80	17.65	13	33.97	2.23	36.20	18 95
14	180 lbs. gossypium phos .... 50 lbs. nitrate of soda.....	18.48	1.60	20.28	14	33.48	2.67	36.15	15.87
15	500 lbs. killed cotton seed....	20.08	.80	20.88	15	29.02	4.02	33.04	12.16

An inspection of the foregoing tabulated statement reveals the fact that the fertilizers applied were without appreciable effect in increasing the crop on either drained or undrained land, but even diminished the yield on some plats of the undrained part. The effects were somewhat better on the drained than on the undrained land, but they were not profitable on either.

The increase as the effect of drainage is very marked in every case, ranging from 6.86 bushels, the lowest, to 20.06 bushels per acre, the highest increase, the average being 12.84 bushels per acre. This is a marked improvement in the effect of the drainage over last year, and a still further increased effect may be expected for the next two years.

The cost of preparing, cultivating and harvesting an acre of the drained land was $6.55. The same on undrained cost $7.05 per acre.

The average yield of corn per acre on drained land was 36.84 bushels, only one-fourth bushel more than the unmanured acre produced. Leaving out, therefore, the cost of the manures used, and the corn cost seventeen and a half cents per bushel when stored in the crib.

Valuing the average product at fifty cents per bushel, and each acre yielded $18.42. Deduct from this the cost of production, $6.55, and a profit of $11.87 per acre remains.

The average yield of the drained land was 36.84 bushels per acre; the average increase caused by drainage was 12.84 bushels per acre. The average yield without drainage was 24.02 bushels per acre. Drainage, therefore, caused an increase of 53.4 per cent. upon the production of the undrained land.

WEIGHT AND SHRINKAGE OF CORN.

[By G. E. Morrow, A. M., Professor of Agriculture, Illinois Agricultural College.]

The following tables give the actual and comparative weights of selected ears of corn of different dates, with weights of shelled corn and cobs in one set. The corn referred to in the first table was taken from the field before fully matured. It will be seen that there is a marked difference in the percentage of loss between the larger and the smaller varieties, and that there was a very noticeable loss during the week after gathering:

	Picked	Weight Sept. 14	Weight Sept. 22	Weight Sept. 20	Weight Jan. 5	Per cent. shrinkage Sept. 14—Jan. 5	Per cent. shrinkage Sept. 22—Jan. 5
Leaming	Sept. 14	21	19½	18½	16	23.8	18.0
Leaming	" 22	.....	20	18½	16	.....	20.0
Murdock	" 14	15	14½	13½	13	13.3	10.3
Murdock	" 22	.....	14½	13½	13	.....	10.3
Smith's Mixed Dent	" 22	.....	15½	.....	14	.....	9.7

The second table shows that, in a favorable season, corn of good quality should have become pretty thoroughly dried by December 1. The ears in this trial were all better than the average of the crop as it came from the field, and were kept in separate lots, hung up in a barn, so that they lost moisture more rapidly than in the ordinary bin or crib. It should also be kept in mind that corn of these varieties in bulk would not have shown so large a percentage of shelled corn to total weight.

PRESENT STATE OF THE SORGHUM INDUSTRY.

[From the Report of the Kansas State Board of Agriculture for Quarter ending December 31, 1887. Wm. Sims, Secretary.]

To the Board of Directors Parkinson Sugar Company:

GENTLEMEN:—I respecfully submit for your consideration the following report of the operations of the works of your company, for the season just closing:

It is provided in our contract with the United States Department of Agriculture that certain experiments in sugar-making shall be made by the Department, with certain machinery of its own and at its own expense, using the company's plant and machinery. Many of those experiments have been so closely allied to and dovetailed into the regular work of the factory, that it is very difficult, if not wholly impossible, to clearly separate the cost of the experimental work from that of the general operation of the factory during the season. At the same time, it is highly important that you know as precisely as possible the cost of working, and the profit or loss on each ton of cane handled.

As you are aware, the crop of cane contracted last spring was very much less than the capacity of our works to consume. It was considered prudent to limit our danger from loss, by reason of the experimental nature of the work, and at the same time to have sufficient cane to determine thoroughly the value of the work on a practical manufacturing basis. This has been done, though it is now apparent that had the crop been twice as large, the expenses for working it would have been relatively much less. Indeed, a crop double the size of the one just finished could have been worked in about the same time, and at a comparatively trifling additional expense. The plans, methods and processes which have made the work of the season successful beyond our most sanguine expectations, were adopted early in the season, so that the risks incident to experiments taken into account when contracting for a crop were reduced to the minimum. The fact that at

least a portion of these highly successful processes were not tried and adopted last season, was no fault of your company, nor of any one connected with this season's work.

To arrive at the cost per ton of cane worked, let us take the working of a single average day, when in full operation, and apart from the cost of experiments referred to.

The capacity of our factory, aside from deficient centrifugals, is limited to the capacity of the diffusion battery. Working twenty-two hours per day, this battery can comfortably handle 135 tons of chips, or cleaned cane. This represents a capacity of field cane, or cane with seed tops and blades, of about 170 tons. To handle this, aside from curing and handling seed, cost us per day of twenty-two hours, when running regularly, as follows:

1 weighmaster, at $2	$2 00
1 team, pulling cane onto storage racks, at $2.50	2 50
5 men, unloading and getting cane to cutters, 22 hours, at 12½ cents	13 75
1 man, cutting machine, at 15 cents	3 30
1 man, cleaning machine, at 12½ cents	2 75
1 man, grinder, etc., at 15 cents	3 30
1 man, oiler, at 15 cents	3 30
3 men, diffusion battery, 1 at car and 2 above, at 12½	8 25
1 man, diffusion battery, director of battery, at 20 cents	4 40
2 men, defecating, at 15 cents	6 60
2 men, double effects, at 15 cents	6 60
1 man, strike-pan, at $5	5 00
1 man, hot room, at 12½ cents	2 75
1 man, barreler, at 12½ cents	2 75
2 men, centrifugals, at 15 cents	6 60
1 man, machinist, at $3	3 00
2 men, engineers, at 20 cents	4 40
5 men, firemen, at 15 cents	16 50
2 men, roustabouts, at 12½ cents	5 50
1 man, water boy	2 00
1 man, night watch	1 50
2 men, foremen, at $2.50	5 00
Total cost of labor	$111 75
Oil, etc	2 50
Coal, 22 tons slack, at 90 cents	20 70
Total	$134 75

This makes the cost of working a ton of cleaned cane, with a factory of the capacity of ours, about one dollar per ton for labor and fuel, or ninety cents per ton of field cane. The cost per ton for salaries, insurance, wear and tear, etc., etc., must depend, of course, not only upon the size of the salaries and other general expenses, but the number of tons worked. This plant, rated as above, is capable, in seventy days, of working 9,450 tons of chips, or 11,900 tons of field cane. There is necessarily considerable expense in preparing for the season's work, and again in closing up. Allowing liberally for this and

for the proper management and control of the works, we may still bring our total expenses, outside the cost of labor and fuel, at one dollar per ton upon the above basis. Add to this the cost of labor and fuel, and we have two dollars per ton as the total cost per ton of working cleaned cane. These figures are fully verified by our pay-rolls, coal bills and other expenses while working to our capacity during the season, separated from expenditures in the completion and changing of machinery directly connected with experiments made. And to work a factory with a capacity at least one-half greater than this one, would require very little additional expense except in the matter of fuel, and that would be relatively less. It seems to me a very conservative basis, with a factory of the capacity of ours, to place the actual cost of manufacture at two dollars per ton of cane; and with such a factory as I have indicated, and with a season of, say seventy days, it is safe to place the cost of manufacture at considerably less than that sum. It requires but little figuring upon this basis, and with the cost of cane at two dollars per ton, and the yield of cane and product secured this year, to show that we have here developed a business of great interest and profit to our State and Nation.

To run a factory at the maximum profit it must be operated constantly during the working season. The loss this season by reason of the irregular operation of the factory for want of sufficient cane, was very considerable. During the whole season the factory was operated but three whole days of twenty-two hours each. Some idea of the loss from this source may be gathered from the fact that not less than two tons of chips were lost at each break in the operation of the diffusion battery. Sixty-five such breaks or stoppages were made while running for sugar. With a larger crop of cane and better arrangements for delivery upon the part of the larger contractors, but little or no difficulty from this source need be apprehended in the future.

Total number tons of cane bought	3,840
Total " " seed tops "	437
Total number tons of field cane	4,277

This represents the crop, less about 30 tons of seed tops yet to come in, from about 450 acres of land. There were something over 500 acres planted. Some of it failed to come at all, some "fell upon the rocky places, where they had not much earth, and when the sun was

risen they were scorched;" so that, as nearly as we can estimate, about 450 acres of cane were actually harvested and delivered at the works. This would make the average yield of cane 9½ tons per acre, or $19 per acre in dollars and cents. I beg to observe, in this connection, that the present was the lightest in tonnage of the five successive crops I have handled. It was probably also the poorest in crystallizable sugar, covering the same period of time, in the State. It may not be amiss to observe, too, in this connection, that a very commonly accepted theory, that "the dryer the weather the sweeter the cane," is not verified by my experience.

Of the total cane worked, 162 tons were consumed in experiments with our cutters and cleaning machinery before the cane was ripe enough for use for either syrup or sugar. No product whatever, not even seed, was saved from this, nor from ten tons additional, brought in since the factory closed down. About 300 tons of mostly down and inferior cane was worked in the early part of the season on the crushers, and without diffusion. The only product from this was molasses, and of that but a small quantity. About 375 tons were also worked for molasses only on the diffusion battery. This, with the exception of 50 tons at the close of the season, and which came in too irregularly to be worked for sugar, was worked before the sugar season began, and comprised such down patches and poorer quality of cane as could be gathered, mainly on the lands belonging to the company. It was an open question whether very poor cane could be worked successfully, even for syrups, on a diffusion battery. Nothing in this direction had hitherto been attempted. The total yield of molasses from this source, and from which no sugar has been taken, is 4,157 gallons. From this are sold 3,157 gallons, for $726.71 net. The remaining 1,000 gallons are still on hand, and is worth 25 cents per gallon.

Deducting from total tonnage, lees seed	3,840 tons.
Amount not worked for sugar (897)	897 "
We have total cane and leaves for sugar	2 943 tons.

The total number of diffusion cells worked for sugar is 2,643. The weight of a cell of chips is 1,975 pounds. With this as a basis there was worked by diffusion for sugar 2,610 tons of clean cane, as it entered the cells. Deducting this from 2,943 tons of cane, with leaves and blades, and we have 333 tons of leaves and blades. The latter are

to us a dead loss. A small portion has been hauled away by farmers for feed, but the bulk of this large tonnage is now fit only for manure. This waste was considerably increased by the failure of our separating machines, especially in the early part of the season, to properly discharge their duties. This whole subject was new; machines had to be devised, and their adjustment, which is not yet perfect, caused considerable loss of cane. The weight of blades and leaves will not be far from 10 per cent. of field cane. For either feed or fuel, especially where the latter is much of an object, the blades can be utilized so as to at least cover their own cost. At present we figure the loss from this source to seed account.

SEED.

There have been delivered of seed tops 437 tons. As nearly as we can estimate, there are yet to be delivered 30 tons, making in all 467 tons. From the best calculations we can make, and judging from our experience in former years, seed yields about 70 per cent. of the weight of heads, as bought in over the scales, in cleaned seed. Putting it at 60 per cent. and with 56 pounds to the bushel, we shall have 10,000 bushels of cleaned seed. A portion of this, estimated at 1,000 bushels, has, at considerable additional expense, been picked over by hand, head by head, tied into small bundles, and hung up in the dry. This has been done to provide ourselves with pure seed of the different varieties for planting, and to supply a probable want in the same direction from others. For this hand-picked seed we expect to get not less than two dollars per bushel. The cost of handling the seed has not been kept separate from the cost of running the factory. The total cost of curing, stacking, and hand picking will not be far from $700, fully $200 of which has been expended in securing pure and perfectly-cured seed for ourselves, and others willing to pay the extra price. To thresh and prepare for market the seed will cost about six cents per bushel additional. I estimate that we shall get for our seed crop $7,000 net. There will be left of seed tops, after threshing, fully 100 tons. These are good for feed or fuel.

FEEDING EXPERIMENTS.

GREEN FODDER CORN; DRIED FODDER CORN; ENSILAGE.

[From New Jersey Agricultural Experiment Station, Bulletin XIX., 1882, Prof. Geo. H. Cook, Director.]

Two very important questions are considered in the following bulletin: First, is the loss of food, by fermentation, when green fodder corn is dried in stacks, greater or less than when it is preserved in a silo? Second, is ensilage more valuable for milk production than dried fodder corn?

To study these questions, an experiment was begun on the college farm on the first of September, 1881. At that time the corn was in the milk, the stalks were very rich in cane sugar and all conditions apparently were favorable for the trial.

The amount of available green fodder corn, by actual weight, was ten tons. Of this one-half was arranged in the field in fifty small stacks; while the other half, after it had been cut by horse power into lengths of three-sixteenths of an inch, was closely packed in a silo of about twelve tons capacity. The analysis of a sample taken with the utmost care to represent the entire quantity used in this experiment, gives the chemical composition of the corn before it was affected either by loss of moisture or by fermentation.

About the last of November, after an exposure to the weather of nearly three months, twelve hundred pounds of the dried stalks were passed through a Lion Cutter and Crusher, then thoroughly mixed and sampled. The analysis of this sample compared with that of the original green corn shows the changes which occurred during the process of field curing.

On the 23d of December the contents of the silo were found to be in an excellent state of preservation. A sample taken eighteen inches from the surface was entirely free from disagreeable smell, insipid to the taste, and as shown by the analysis equal in all respects to the best ensilage which has yet been received at this station. The chemical composition of these three samples can be seen in the following table.

It should be remembered that sample No. I. represents the green corn, while samples Nos. II. and III. represent fodders obtained from this corn by two different methods of preservation.

TABLE NO. I.

	No. I. Green Stalks.	No. II. Dried Stalks.	No. III. Ensilage.
Water	75.00	39.37	74.70
Ash	1.58	4 63	1.95
Protien	1.25	3.84	1.75
Fat	.22	.66	.27
Fibre	6.35	18.65	7.86
Carbo-hydrates	15.60	32.85	13.47
	100.00	100.00	100.00

On account of the different amounts of water in these samples, their relative compositions are not plainly seen. Comparisons between them can be easier made by arranging the results in another table, in which the composition of 100 pounds of the dry matter of each sample is given. Table No. II. is computed for this purpose.

TABLE NO. II.

	No. I. Green Stalks.	No. II. Dried Stalks.	No. III. Ensilage.
Ash	6.32	7.64	7.71
Protein	5.00	6.33	6.92
Fat	.88	1.09	1.06
Fiber	25.40	30.76	31.07
Caro-bhydrates	62.40	54.18	53.24
	100.00	100.00	100.00

The ash of corn stalks is that portion which cannot be destroyed by fire. It is not in the least affected by fermentation, nor is it probable that its total amount was in any way changed either after the corn

was packed away in the silo or after it was stacked. It is therefore adopted as a standard in comparing the above analyses.

It has been shown that one hundred pounds of the green corn contained seventy-five pounds of water; four hundred pounds therefore of this corn would have yielded one hundred pounds of dry matter containing 6.32 pounds of ash. The question now is, *what is the weight of dry matter in the ensilage and in the field cured stalks which contains 6.32 pounds of ash?* A simple calculation from the figures in table No. II. gives the following results:

TABLE NO. III.

	No. I. Green Stalks.	No. II. Dried Stalks.	No. III. Ensilage.
Ash	6.32	6.32	6.32
Protein	5 00	5.24	5.67
Fat	.88	.90	.86
Fiber	25.40	25.44	25.49
Carbo-hydrates	62.40	44.82	43.64
Total weight dry matter	100.00 lbs.	82.72 lbs	81.98 lbs.

Eighty-two pounds of the dry matter of the ensilage and eighty-two and three-quarter pounds of the dry matter of the field cured stalks now contain the same weight of ash which one hundred younds of the dry matter of the green corn contained. *During the process of field curing therefore four hundred pounds of green corn lost seventeen and one-quarter pounds of dry matter; while four hundred pounds of green corn packed in a silo lost eighteen pounds of dry matter.* Table No. III. shows further that neither the field cured corn nor the ensilage suffered a loss of protein, fat or fiber, but that the total loss fell upon the class, carbo-hydrates, which includes sugar, starch etc., the least costly ingredients of fodders.

Admitting now that quite as much of the dry matter of green corn was preserved, *in this experiment,* by field curing as by packing in a silo, there remains still several important questions to be considered. First, will cows eat the dried corn fodder as readily and with as little waste as they will eat ensilage? Second, how does the milk of cows which are fed dried fodder corn compare in quantity and quality with the milk of the same cows when ensilage is used?

A feeding trial was begun on the sixth day of December, for the purpose of studying these questions. Four cows were selected from the herd, placed side by side, fed, watered and exercised at the same time, and for sixty consecutive days treated in all respects as nearly alike as was possible.

During the first period of twenty days all four cows were fed the same daily ration made up for each 1,000 pound of live weight of

	Fat.	Protein.	Carbo-hydrates.
	lbs.	lbs.	lbs.
20 lbs. of dried fodder corn, containing	.10	.57	7.08
3 lbs. winter wheat bran, containing	.10	.40	1.38
30 lbs. brewers' grains, containing	.40	1.58	3.00
Total digestible food	.60	2.55	11.46

The digestibility of the dried corn is here assumed to be the same as green corn.

During the second period of twenty days the daily ration for two of the cows was the same as during the first period; the other two were fed ensilage instead of dried fodder corn. For each 1,000 pounds of live weight this second ration was

	Fat.	Protein.	Carbo-hydrates.
	lbs.	lbs.	lbs.
50 lbs ensilage, containing	.10	.64	7.34
3 lbs. winter wheat bran, containing	.10	.40	1.38
30 lbs. brewers' grains, containing	.40	1.58	3.00
Total digestible food	.60	2.62	11.72

The digestibility of the ensilage is here assumed to be the same as green corn.

This ensilage ration was fed to all four cows during the third period of twenty days.

The dried fodder corn, as stated above, was cut and crushed in a machine which leaves it in such a condition that cows can eat it easily. After the first day or two in the first period, the dried corn ration was eaten without waste. During the second period one of the cows

seemed unable to eat all of the harder pieces of ensilage; the amount wasted, however, was regarded as too small to be taken into account. *The facts, therefore, seem to show that dried fodder corn when cut and crushed is eaten quite as readily and with as little waste as ensilage.*

During the entire experiment the cows were milked twice daily, at 4 A. M. and 4 P. M. The milk of each cow was weighed separately and its weight at once recorded.

Analyses of the milk were made on five consecutive days in each period. For this purpose sample No I. represented the total daily yield of cows I. and II., while sample No. II. represented that of cows III. and IV. Results obtained when the cows were fed ensilage are for the sake of comparison marked thus *

Number of each cow.	I.	II.	III.	IV.
Calved	Nov. 14, '81.	Nov. 23, '81.	Aug. 1, '81.	Aug. 1, '81.
Served	Jan. 27, '82.	Jan. 7, '82.	Sept. 18, '81	Oct. 1, '81,
Yield of milk during 1st period...	624 lbs.	540 lbs.	339 lbs.	350 lbs.
Yield of milk during 2d period....	624 lbs.	526 lbs.	*340 lbs.	*401 lbs.
Yield of milk during 3d period....	*579 lbs.	*500 lbs.	*300 lbs.	*386 lbs.
Total yield of each cow for 60 dys	1,827 lbs.	1,566 lbs.	979 lbs.	1,137 lbs.

In the following tables cows I. and II. form herd No. 1, cows III. and IV. herd No. II. The analytical results given below are *averages*, drawn from the daily determinations of the milk of five consecutive days in each period.

	Herd No. I.					Herd No. II.				
	Specific gravity	Total solids....	Butter.....	Protein.....	Sugar and ash..	Specific gravity	Total solids....	Butter.....	Protein.....	Sugar and ash..
First period.....	10340	13.55	4.27	3.31	5.87	10340	13.87	4.27	3.43	6.17
Second period.....	10327	13.55	4.49	3.11	5.95	*10343	*14.01	*4.42	*3.41	*6.18
Third period.....	*10330	*13.87	*4.58	*3.20	*6.09	*10346	*14.51	*4.53	*3.59	*6.39

As cows advance in their periods of lactation, the per cent. of solid matter in their milk gradually increases; while the yield of milk, as is well known, decreases. A second table is therefore given, in which the absolute amounts of butter, protein, etc., yielded by each herd during each period are compared:

	Total solids		Butter.		Protein.		Sugar and ash.	
	Herd I.	Herd II.	Herd I.	Herd II.	Herd I.	Herd II.	Herd I.	Herd II.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Total weight yielded during 1st period	157.7	95.5	49.7	29.4	38.5	23.6	68.3	42.5
Total weight yielded during 2d period	155.8	*103.8	51.6	*3.27	35.8	*2.52	68.4	*45.8
Total weight yielded during 3d period	*149.6	*99.5	*49.4	*3.10	*34.2	*24.6	*65.7	*43.8

A summary of the facts shown in the above experiment is as follows:

First. When the green corn was dried in stacks the loss of food was less than it was when the corn was packed in a silo.

Second. When dried corn fodder was cut and crushed it was eaten by the cows under experiment quite as readily and with as little waste as ensilage.

Third. In three cases, the yield of milk was not increased when ensilage was substituted for dried corn, but in one case ensilage caused an increase of eighty-seven pounds of milk in forty days.

Fourth. In the mixed milk for twenty days of herd No. I., ensilage caused no increase in the yield of total solid matter; while in the milk of herd No. II. for the same period it caused a gain of eight and one-third pounds, or seven per cent.

ENSILAGE VERSUS FODDER CORN.

[From Wisconsin Agriculture Experiment Station IV., 1886, pages 25-27, by Prof. W. A. Henry, Director.]

The ensilage and fodder corn of the two trials here reported were made by taking an equal number of rows of fodder corn for each lot and shocking one part and cutting and putting the other into a small

silo made for the purpose. The varieties were dent corn, sweet corn and southern ensilage corn in equal amounts by weight. The pit in which the ensilage was kept was a small one made for the purpose, of boards and building paper. Most of the ensilage made by slow filling was of excellent quality, having that sweet smell characteristic of good ensilage, but here and there through the mass was a patch of mould. This was carefully separated and only good ensilage fed. It seems much more difficult to keep ensilage in small quantities than in large bulk. The fodder corn was stored in the barn after it was cured, and was run through the fodder cutter and made fine for feeding. We had then, it will be noted, ensilage and dry fodder corn from the same field in the same proportions and each cut up fine for our feeding trial. Four fresh cows were selected, placed two and two, and one lot fed ensilage and the other corn fodder for twenty-two days. At the close of this trial the feeds were reversed and the trial repeated for twenty-two days. The first seven days of each trial were thrown out as preliminary feeding, and only the data of the last fifteen days of each trial here reported. It was deemed advisable not to feed the cows a heavy grain ration, as by so doing we might conceal the real value of coarse food; accordingly each cow received daily only two pounds of corn meal and four pounds of bran, fed dry in two feeds. As much fodder and ensilage was fed as the cows would eat up without waste, but no more.

The milk and butter from each lot was saved separately, and is given in the accompanying tables. The trial began November 20, 1886. The tables give the data of the two trials in a condensed form.

RESULT OF FEEDING ENSILAGE.

	Feed Consumed.			Product.			
	Ensilage.	Bran.	Corn meal.	Milk.		Butter.	
	lbs.	lbs.	lbs.	lbs.	oz.	lbs.	oz.
Lot I. Emma and Rose, 15 days	2,294½	120	60	696	11	26	5
Lot II. Sylvia and Palmer, 15 days	2,256	120	60	585	11	33	12
Total, 4 cows, 15 days each	4,550½	240	120	1,282	6	60	1

RESULTS OF FEEDING CORN FODDER.

	Feed consumed.			Product.			
	Corn Fodder.	Bran.	Corn meal.	Milk.		Butter.	
	lbs.	lbs.	lbs.	lbs	oz.	lbs.	oz.
Lot II. Sylvia and Palmer.....	955	120	60	625	10	31	10
Lot I. Emma and Rose.....	735	120	60	619	1	26	4
Total, 4 cows, 15 days each.....	1,690	240	120	1,244	11	57	14

Simplifying our results, we have:

1,690 lbs. corn fodder plus 360 lbs. bran and corn meal equal 1,244 lbs. 11 oz. milk, equal 57 lbs. 14 oz. butter.

1,550 lbs. ensilage equal 360 lbs. bran and corn meal equal 1,282 lbs. 6 oz. milk, equal 60 lbs. 1 oz. butter.

Excess in favor of ensilage, 37 lbs. 11 oz. milk, 2 lbs. 3 oz. butter.

This shows that we obtained about 3 per cent. more milk and butter by feeding ensilage than from feeding the same material in the shape of corn fodder, cut fine with the feed cutter. 21.3 pounds of milk from ensilage, and 21.7 pounds of milk from fodder were required for one pound of butter.

The fodder and ensilage were sampled for analysis, but at this date only the amounts of water determined. The analysis shows:

Water in ensilage as feed.....	79.28 per cent.
Solids in ensilage as feed.....	20.82 "
Water in fodder as feed.....	44.15 "
Solids in fodder as feed.....	55.85 "

From this it will be found that we fed 932.37 pounds of dry matter in our corn fodder and 942.86 pounds of dry matter in our ensilage. Ignoring the grain fed, we have as the value of the dry matter the following:

16.11 lbs. of dry matter in corn fodder equal 1 lb. of butter.
15.69 lbs. of dry matter in ensilage equal 1 lb. of butter.

It will be noted that we have obtained practically equal results with fodder, corn and ensilage in this case. The results, it is true, are slightly in favor of ensilage, but the difference falls within what is styled in the laboratory, "the limits of error."

The fall of 1886 was with us on the whole the most favorable for curing fodder I have seen since coming into the State seven years ago.

SHELLED CORN AND BRAN VERSUS CORN MEAL AND BRAN FOR STEERS.

[From Wisconsin Agricultural Experiment Station, Report IV., 1886, pp. 56 and 59, Prof. W. A. Henry, Director.]

The following trials were conducted during the winter of 1886 and 1887.

The weight of the steers on the day the trial began was as follows:

Lot I.		Lot II.	
No. 1	780 lbs.	No. 1	878 lbs.
No. 2	804 "	No 2	738 "
No. 3	808 "	No. 3	809 "
No. 4	835 "	No. 4	805 "
No. 5	854 "	No. 5	817 "
No. 6	742 "	No. 6	785 "
Total	4,823 "	Total	4,832 "

They were weighed daily during the whole trial. The weights used in all calculations were obtained by taking the average of three weights, that of the day the experiment began or closed and the day before and after.

The twelve steers, after being dehorned, were divided into two lots of six each, and to one lot was given shelled Iowa yellow dent corn and bran, mixed, two-thirds corn and one-third bran, by weight. To the other lot was fed the same corn ground into meal and fed along with one-third its weight of bran. The purpose of the experiment was to throw light on the question of grinding feed for stock.

Each lot had a room 25x26 feet, with feed box along one side, and above and back of this a large rack for hay. All hay, grain and bedding given were carefully weighed. Water was furnished in abundance, being pumped into a tank in the shed direct from the well. The endeavor was to feed each lot as much grain feed as could be eaten without getting the animals off feed. The feeding was done by a man experienced in feeding cattle and was very successfully conducted. A

week of preliminary feeding preceded each trial, which lasted twenty-five days. When the first period was completed, the feed of the two lots was reversed and the trial repeated. Each lot of steers, it will be noted, were on both sides of the experiment.

The table gives, in a condensed form, the results:

SHELLED CORN AND BRAN VERSUS CORN MEAL AND BRAN FOR STEERS.

Shelled corn and bran. (Each period 25 days.)				Corn meal and bran. (Each period 25 days.)			
	Shelled corn and bran.	Hay.	Gain.		Corn meal and bran.	Hay.	Gain.
	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.
Lot I.....	1,885	2,520	389	Lot I.....	1,869	2,804	453
Lot II.....	2,022	1,969	320	Lot II.....	2,022	2,123	383
Total.....	3,907	4,489	709	Total.....	3,891	4,927	836

It is seen that from the ground corn and bran ration, we made a gain of 127 pounds over the unground corn and bran. To do this the meal and bran fed steers ate 16 pounds less grain ration and 436 pounds more hay.

Valuing the grain ration at $15 per ton and the hay at $8 per ton, we may place our results in this shape:

I. SHELLED CORN AND BRAN.	
3,907 lbs. grain, at $15 per ton.....	$29 30
4,489 lbs. hay, at $8 per ton.....	17 95
Total cost of feed in two trials.....	$47 25
Cost of feed to make 100 lbs. gain.....	$6 66
II. CORN MEAL AND BRAN.	
3,891 lbs. grain, at $15.....	$29 18
4,927 lbs. hay at $8.....	19 70
Total cost of food in two trials.....	$48 88
Cost of feed to make 100 lbs. gain.....	$5 83

We see, then, that allowing good prices for the feed consumed, we have our gain in weight costing us $6.66 per 100 pounds with shelled corn, bran and hay in the one case, and $5.83 per 100 pounds with corn meal, bran and hay in the other. This, however, is assuming that corn meal is the same price as shelled corn, which is hardly correct. Two-thirds of the grain ration was corn meal and the other third bran. Valuing the corn meal at $17.00 per ton and the bran at $15.00 we have with corn meal fed steers the following as cost of feed:

2,594 pounds of corn meal at $17	$22 04
1,267 pounds of bran at $15	9 72
4,927 pounds of hay at $8	19 70
Total cost of feed	$51 46

Dividing by the gain we get $6.15 as the cost of 100 pounds of gain, or 51 cents per 100 pounds of gain saved by feeding meal instead of shelled corn, and when paying $2 per ton more for meal than shelled corn.

COOKED AND RAW CORN AS FOOD FOR FATTENING PIGS.

[From Report of Kansas State Agricultural College, 1885, by E. M. Shelton, Professor of Agriculture.]

The value of cooked corn as compared with corn in the raw state was the subject of the experiment hereinafter detailed. Ten pigs, with one exception yearlings, were selected for the purposes of this experiment. * * * The corn was weighed before cooking and after, and the proportion of water absorbed in the cooking process subtracted in the case of every feed of every pig. The comparisons, therefore, wherever made, are of cooked corn, weighed before it was cooked, with raw corn simply. In cooking, no set rule was followed except that the corn was so thoroughly acted upon by the heat that each grain might easily be crushed between the thumb and finger. The cooking was done in an ordinary barrel, which was connected with a steam boiler by a half-inch steam pipe which supplied the barrel with steam at a boiler pressure varying from 30 to 60 pounds to the square inch. * * *

For convenience in making a comparison of results, the following summary, giving the principal facts of the foregoing tables with others in concise form, has been arranged:*

	Total Feed.....	Total Gain.....	Feed consumed for each pound of increase....	Average daily feed of each pig.....	Average daily gain of each pig.....	Gain per cwt of each pig.....	Average gain per pig.....
Feed—cooked corn. Pigs No. 1, 2, 3, 4 and 5.	3894	520	7.5	8.6	1.1	47.5	104
Feed—raw corn. Pigs No. 6, 7, 9 and 10.	3811	605	6.3	8.4	1.68	59.8	151

COOKED VERSUS UNCOOKED FOOD FOR SWINE.

[From Wisconsin Agricultural Experiment Station, Report IV., 1886, pp. 64-80. Prof. W. A. Henry, Director.

The uncooked meal was fed dry in every instance.—Each lot of hogs was fed three times daily what could be eaten up clean and after all food in the trough was consumed, drinking water was poured in sufficient for their wants. In cold weather this water was warmed alike for each lot so as not to freeze in the troughs. The hog house in which the trials were made was warmly constructed, but water freezes in it during extremely cold weather.

It is important to note that in every trial here reported, each lot of hogs was fed for not less than seven days previous to beginning the trial, upon exactly the same feed as given during the trial, so that at the commencement of the trial the weight of each should not be abnormally heavy or light as might have been the case if we had started the trial the day we started to give any particular feed.

* Four other tables are omitted. Sec'y.

BARLEY MEAL.

	Cooked.			Uncooked.		
	Meal fed.	Weight of hogs at beginning.	Gain in 23 days.	Meal fed.	Weight of hogs at beginning.	Gain in 23 days.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
First trial	392	390½	46½	400	379	85
Second trial	406	465	68	430	450	50
Total	798	855½	114½	830	829	135

II. CORN MEAL AND SHORTS.

Hogs used in this trial answer the same description as given under I., Barley Meal.

CORN MEAL AND SHORTS, EQUAL PARTS.

	Cooked.			Uncooked.		
	Meal fed.	Weight at beginning.	Gain in 23 days.	Meal fed.	Weight at beginning.	Gain in 23 days.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Third trial	400	410	76	407	390	89
Fourth trial	428	493	64	443	507	64
Total	828	903	140	850	897	153

III.—BARLEY MEAL.

For the next trial four grade Poland China hogs, six or seven months old, were purchased, and to these we added two grade Jersey Reds of about the same age of our own raising. They were divided into two lots of three each, and after a week's preliminary feeding the trial was started December 9, 1886, and each lasted twenty-one days.

BARLEY MEAL.

	Cooked.			Uncooked.		
	Meal fed.	Weight at beginni'g	Gain in 23 days.	Meal fed.	Weight at beginni'g.	Gain in 23 days.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Fifth trial.....	397	497	76	395	493	67
Sixth trial.....	380	611	69	380	586½	81½
Total.....	777	1,108	145	775	1,079½	148½

IV. CORN MEAL.

The hogs fed on corn meal and shorts in II., were used in this trial, the feed being corn meal. The first trial began January 4, 1887, and each lasted 21 days.

CORN MEAL.

	Cooked.			Uncooked.		
	Meal fed.	Weight at beginni'g	Gain in 23 days.	Meal fed.	Weight at beginni'g	Gain in 23 days.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Seventh trial.....	400	597	64	432	616	77
Eighth trial.....	406	715	78½	365	657	85½
Total.....	806	1,312	142½	797	1,273	162½

I add to these eight trials two more made with uncooked and cooked feed given in the last report of this Station.*

* See Third Annual Report Wisconsin Agricultural Experiment Station, pp. 36-37.

	Pounds.
I—COOKED FOOD.	
Amount of shorts fed	165⅓
Amount of shelled corn fed	331
Weight of 3 hogs at beginning	464
Gain in 21 days	82
II—UNCOOKED FOOD.	
Amount of shorts fed	180
Amount of shelled corn fed	360
Weight of 3 hogs at beginning	447
Gain in 21 days	110
I—COOKED FOOD.	
Amount of shorts fed	286
Amount of shelled corn fed	143
Weight of 3 hogs at beginning	467
Gain in 21 days	82
II—UNCOOKED FOOD.	
Amount of shorts fed	293
Amount of shelled corn fed	146½
Weight of hogs at beginning	437
Gain in 21 days	94

In order that our results may be made more intelligible, let us summarize them, calculating in each trial how many pounds of feed were required for 100 pounds of pork, live weight. We may state these results thus:

BARLEY MEAL REQUIRED FOR 100 POUNDS OF PORK, LIVE WEIGHT.

	Cooked.	Uncooked.
	lbs.	lbs.
First trial	843	441
Second trial	597	860
Fifth trial	522	589
Sixth trial	551	466
Average	628	589

Or 39 pounds of barley meal lost by cooking in making 100 pounds of pork, live weight.

CORN MEAL REQUIRED TO MAKE 100 POUNDS OF PORK, LIVE WEIGHT.

	Cooked.	Uncooked.
	lbs.	lbs.
Seventh trial	625	561
Eighth trial	517	426
Average	571	493

Or a loss of 78 pounds by cooking, in feeding corn meal sufficient to make 100 pounds of pork, live weight.

CORN MEAL AND SHORTS, HALF AND HALF, REQUIRED TO MAKE 100 POUNDS OF PORK, LIVE WEIGHT.

	Cooked.	Uncooked.
	lbs.	lbs.
Third trial	526	457
Fourth trial	668	692
Average	597	574

A loss of 23 pounds of corn meal and shorts in cooking the food required to make 100 pounds of pork, live weight.

WHOLE CORN AND SHORTS REQUIRED TO MAKE 100 POUNDS OF LIVE WEIGHT.

	Cooked.	Uncooked.
	lbs.	lbs.
Ninth trial	605	491
Tenth trial	523	478
Average	564	484

Or a loss of 80 pounds, chargeable to cooking the corn and shorts.

It will be noted that the results of the trials with each and every one of the several food articles used are against cooking. Here are

the results of ten feeding trials, or five in duplicate and all point most plainly to the one conclusion. * * * * * * * *

At the Maine Agricultural College feeding trials were conducted for nine years ending 1878, with cooked and uncooked corn meal. The following is a summary of the results.

RESULTS OBTAINED FROM THIS EXPERIMENT FOR NINE YEARS.

In 1870 scalded meal fed warm was to raw meal fed cold, as.....	95.5 to 100
In 1871 value of cooked meal was to value of raw meal as.....	74.8 to 100
In 1872 value of cooked meal was to value of raw meal as.....	82.0 to 100
In 1873 value of cooked meal was to value of raw meal as.....	91.6 to 100
In 1874 value of cooked meal was to value of raw meal as.....	98.8 to 100
In 1875 value of cooked meal was to value of raw meal as.....	72.3 to 100
In 1876 value of cooked meal was to value of raw meal as.....	88.8 to 100
In 1877 value of cooked meal was to value of raw meal as.....	64.2 to 100
In 1878 value of cooked meal was to value of raw meal as.....	78.5 to 100

Thus we see that in no instance was the cooked meal so valuable as the raw meal. Results running so uniformly against a practice for so long a period should certainly be given much weight.

ARTIFICIAL DIGESTION OF COOKED AND UNCOOKED CORN MEAL

At the New York Experiment Station, the Assistant Chemist, Mr. B. F. Ladd, conducted some highly interesting experiments in digesting artifically, two samples of corn meal, one recently ground and one ground some three months before the trial. Of each of these samples one part was cooked and another uncooked. The digestion was effected by a pepsin solution. * * * * * * * *

The figures as given are:

	Old Meal.		Fresh Meal.	
	Raw.	Cook'd.	Raw.	Cook'd.
Fat	5.41	3.85	5.77	4.38
Crude fibre	2.33	2.47	2.55	3.61
Total nitrogen	1.670	1.580	1.975	1.800
Albuminoid nitrogen	1.222	1.217	1.505	0.831
Amides	0.448	0.363	0.470	0.969
Per cent. nitrogeneous matter digested	72.58	63.17	68.63	60.53

This work is highly suggestive, and confirming as it does the results of so many actual trials in feeding cooked and uncooked food with swine must be looked upon as strong corroborative evidence.

DIGESTIBILITY OF TIMOTHY HAY.

[From report of Maine Agricultural Experiment Station, 1885-6, pp. 55-58—Prof. W. A. Jordan, Director.]

The animal used in the feeding trials was a full-grown wether. * * He was fed during three periods, the first two periods occupying twelve days each, and the third eleven days. The dung was collected for the last five days in Periods 1 and 2, and for the last four days in Period 3, being received in a rubber lined bag attached to the sheep by means of a harness. * * * * * * *

TABLES SHOWING THE DIGESTIBILITY OF TIMOTHY HAY.

PERIOD 1.

	Dry substance.	Organic matter.	Protein.	Crude Fibre.	Nitrogen-free Extractive matter.	Fats.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Fed, 600 grams hay	534.3	510.3	42.	183.6	270.6	14.1
Fed, 200 grams corn meal	164.	161.2	20.	4.2	128.8	8.2
Total	698.3	671.5	62.	187.8	399.4	22.3
Excreted, 764.2 grams dung	259.4	234.5	28.1	92.4	104.7	9.3
Total digested	438.9	437.0	33.9	95.4	294.7	13.0
Digested from the corn meal	.....	143.5	15.8	2.6	117.2	6.9
Digested from the hay	.....	293.5	18.1	92.8	177.5	6.1
Per cent. digested from hay	.....	57.5	43.0	50.5	65.6	42.8

EXPERIMENT IN FEEDING WHOLE CORN AND MEAL.

[From Maine Agricultural Experiment Station, 1886-7, pp. 97-105—By W. A. Jordan, Director.]

The six pigs used in the feeding trial were Chester White, from the same litter. They were divided into two lots, so that the weight and appearance of the three pigs in each lot was as nearly alike as possible.

At the time of beginning the feeding the pigs were about five months old, their average weight being not far from 85 pounds.

The whole time of experimental feeding was one hundred and ninety-four (194) days, which was divided into two periods, the first period being 78 days and the second 116 days. In the second period the rations were reversed, and the lot of pigs which had in the former period received corn were fed meal, and those which had previously eaten meal were given corn.

The rations were the following:

PERIOD 1.

Lot 1.	Lot 2.
6 pounds meal,	6 pounds whole corn,
6 " raw potatoes,	6 " raw potatoes,
Milk.	Milk.

PERIOD 2.

Lot 3.	Lot 4.
8 pounds whole corn,	8 pounds meal,
6 " raw potatoes,	6 " raw potatoes,
Milk.	Milk.

	Meal—Lot 1.	Whole Corn—Lot 2.
Period 1, weight December 28th	260 lbs.	255 lbs.
" " March 16th	416 "	418 "
Gain in 78 days	156 lbs.	163 lbs.
	Lot 2.	Lot 1.
Period 2, weight March 28th	436 lbs.	451 lbs.
" " July 25th	665 "	675 "
Gain in 116 days	229 lbs.	224 lbs.
Total gain in 194 days	385 "	387 "

Reckoning the corn at 64 cents per bushel and the meal at 60 cents for fifty pounds, the potatoes at 40 cents per bushel, and the skimmed milk and buttermilk at one and one-half cents per gallon, in each case the cost of the food was greater than the market value of the pork produced. The cost of the growth was 7.2 cents per pound live weight with the meal-fed pigs, and 6.95 cents with the corn-fed.

EXPERIMENT IN FEEDING CORN MEAL AND CORN-AND-COB MEAL.

The relative value of corn meal and corn-and-cob meal is another point about which various opinions are held. It is argued in favor of grinding the ears of corn without shelling that the ground cob not only furnished some nutriment but aids digestion by causing the mass of food in the stomach to be less compact and more readily acted upon by the digestive fluids. The statement often appears in agricultural literature that one pound of finely ground corn-and-cob meal is equal in value one pound "clear" meal. It remains to be seen whether these opinions will stand the test of carefully conducted experiments. It certainly does not appear from the general knowledge that we have concerning the composition of corn-and-cobs and the digestibility of clear meal that these extreme views can be substantiated. Certainly the results of the Station experiment in feeding clear meal and corn-and-cob meal are not favorable to crediting cobs with very much nutritive value.

The data collected by the Station show that on the average almost exactly one-fifth of the weight of dry ears of corn consists of cobs, consequently five pounds of corn-and-cob meal would contain four pounds of clear meal and one pound of ground cobs. Accordingly, in this experiment one lot of three pigs was fed four pounds of clear corn meal and the other lot five pounds of corn-and-cob meal daily. The two lots of pigs were quite uniform in size and quality, being from the same litter. The age of the pigs at the beginning was five months. The feeding was continued for 81 days, with the rations given below.

Lot 3.	Lot 4.
4 lbs. clear meal,	5 lbs. corn-and-cob meal,
3 lbs. potatoes,	3 lbs. potatoes,
Milk.	Milk.

The gain of the two lots is next shown.

	Lot 3.	Lot 4.
Weight, May 5th	244	206
" July 25th	380	335
Gain in 81 days	136	129

This experiment would have been more satisfactory if the feeding had been continued during a second period with the rations changed about. So nearly alike were the two lots of pigs, however, that it does not seem possible that the presence of a pound of ground cobs in the food of Lot 4 could have added greatly to the nutritive value of the ration without the effect being seen in increasing their growth over that made by Lot 3.

It is proper to state that the corn-and-cob meal was ground fine.

EXPERIMENT WITH RAW AND BOILED POTATOES.

It has been shown on previous pages that the composition of potatoes is only slightly changed by boiling.

As in the two preceding feeding trials, the experimental animals consisted of six pigs which were selected from the same litter.

The first feeding period extended through forty-four days, the daily rations being the following:

Lot No. 3.	Lot No. 4.
15 pounds raw potatoes,	15 pounds potatoes, boiled,*
1 pound corn meal,	1 pound corn meal,
4 quarts milk.	4 quarts milk.

* Weighed before boiling.

On these rations the two lots of pigs made the following gain:

	Lot 3.	Lot 4.
	lbs.	lbs.
Weight, December 28th	119	121
" February 11th	179	188
Gain in 44 days	60	67

On changing the rations about, the pigs of Lot 4 were reluctant to eat raw potatoes, and it was nearly four weeks before the three would eat as much as ten pounds a day. Even then their food did not seem to be relished, and the potatoes were not promptly eaten. Consequently the experiment did not proceed satisfactorily during the second period, and the results obtained are not reported here.

RATIONS FOR POULTRY RAISING.

The question of economy in the compounding of rations for the production of milk, meat and wool has received much study, from which valuable results have been secured. There seems to be no reason why an experimental study of the use of various classes of foods in poultry production would not lead to greater economy in this department of feeding, especially as this matter has not been the subject of very much investigation. A beginning, and only a beginning, in this direction has been made at the station.

The question proposed, which has been the subject of only one experiment so far, is, whether in feeding poultry for growth an advantage would be gained by substituting in a grain ration some highly nitrogenous food, like oil meal, meat scrap, etc.? The experiment mentioned was carried on in October and November, 1886, twenty-four pure bred Plymouth Rock cockerels being used. These were divided into lots of twelve each, the birds in each lot being as nearly alike in age and size as possible, and were confined in two roomy pens. In addition to the experimental food the cockerels were given a small, equal amount of potatoes each day or two, and they had access to ground clam shells, gravel and fresh water. Equal weights of food were fed to each lot throughout the experiment, consisting in one case of cracked corn alone, in the other case being a mixture of cracked corn and some highly nitrogenous food. An attempt was made at first to feed for the latter ration a mixture of corn and cotton-seed meal, but this was given up as a failure after several days' trial, even a small quantity of this mixture being eaten with reluctuance. Beef scrap was then substituted for the cotton-seed meal, with good results.

The quantities fed at first, beginning October 8th, were as follows:

Lot 1. 640 grams* cracked corn, daily, or at the rate of one quart by weight, to fifteen birds.

Lot 2. 540 grams cracked corn, daily, 100 grams beef scrap, daily. Total, 640 grams.

On October 19th the rations were increased:

Lot 1. 800 grams cracked corn, daily, or at the rate of one quart by weight, to twelve birds.

Lot 2. 600 grams cracked corn, daily, 200 grams beef scrap daily. Total, 800 grams.

On October 11th the two lots were weighed, and again on October 28th. The weights at the two dates are given below:

*One pound—454 grams.

	Oct. 11th.	Oct. 28th.	Gain.
	lbs.	lbs.	lbs.
Lot 1	35⅓	39½	4
Lot 2	35	43¾	8¾

It seems, then, that in seventeen (17) days the twelve birds which were fed pure cracked corn gained four (4) pounds, and that those which were given a ration of equal weight in which beef scrap was substituted for a portion of the corn gained 8 3-4 pounds. This was an average gain of one third of a pound for each bird in the first lot, and almost three-fourths of a pound for each bird in the second lot.

The pounds of food eaten in the seventeen days, with the cost of the same, are given below. The corn is reckoned at 62 1-2 cents for fifty pounds, and the beef scrap cost 2 1-2 cents per pound.

	Corn.	Scrap.	Total fed.	Cost of food.	Cost per lb. of gain.
	lbs.	lbs.	lbs.	cts.	cts.
Lot 1	27½	.....	27½	39½	8.6
Lot 2	21½	6	27½	43¾	4.77

On October 29 an equal weight of dried blood was substituted for the beef scrap, the weights of corn fed in the two cases remaining the same, and these rations were fed for fourteen days.

Below can be seen the weights of the two lots at the beginning and end of this period:

	Oct. 29th.	Nov. 12th.	Gain.
	lbs.	lbs.	lbs.
Lot 1	39½	43¾	4¼
Lot 2	43¾	47¼	3½

Here the advantage seems to be slightly with the pure cracked corn, which tends to throw suspicion on the correctness of the result when beef scrap was fed. There is quite a difference in the composition of the beef scrap and blood, which can be seen by the following analyses:

	Water.	Ash.	Albuminoids.	Carbohydrates.	Fat.
Beef scrap	1.33	8.3	57.69	.....	32.95
Dried blood	6.69	6.64	65.12	.....	16.23
Corn (average)	10.54	1.55	10.59	69.73	5.49

An equal weight of the blood contains only about half as much fat as the scrap, but this difference alone does not seem sufficient to explain the apparent difference in effect.

One important point should be noticed in this connection, which is the value of the growth as compared with the cost of the food. The 24 cockerels gained in the 32 days 20 1-2 pounds, this increase having a value of at least $2.50. They consumed 94 pounds of corn and 12 1-2 pounds of scrap and blood, the whole costing $1.50. The half bushel of small potatoes fed had scarcely any market value.

Certainly no other form of meat can be produced in Maine at a cost for food of three-fifths of its market value.

WILL IT PAY TO RAISE THE CALVES OF DAIRY COWS FOR BEEF.

[From Wisconsin Agricultural Experiment Station Report IV., 1886, page 44, Prof. W. A. Henry, Director.]

In our cheese districts, thousand of calves are slaughtered each season, many dairymen raising none whatever, but buying cows as they may need them to keep up their herds. This great slaughter has led some persons to urge that a part at least of these calves be reared to maturity, arguing that there would be a profit in the business. * *

Accordingly, Mr. H. J. Anderson, a butcher at Lake Mills, Jefferson county, secured for us early in June, 1885, nine calves from farmers in that vicinity supplying cheese factories with milk. Seven ordinany calves were purchased about Madison. As they came to us they were from four days to four weeks old, and were on the whole a fair lot.

To facilitate the study of this experiment, the time has been divided into periods and the gain in weight and amount of food consumed during each period is stated by itself.

FIRST PERIOD, JUNE 22, 1885, TO SEPTEMBER 28—14 WEEKS.

Herewith is given the amount of food consumed during this period by the 16 calves, together with its value at prices stated:

Sweet skim-milk, 20,645 lbs., at 25 cents per 100 lbs	$51 61
Ground oats, 175 lbs., at $20 per ton	1 75
Ground corn, 373 pounds, at $16 per ton	2 98
Ground corn and oats, 240 pounds, at $18 per ton	2 16
Ground wheat, 196 pounds, at $20 per ton	1 96
Ground barley, 85 pounds, at $20 per ton	85
Bran, 506 pounds, at $12 per ton	3 03
Shorts, 563 pounds, at $14 per ton	3 94
Hay, 420 pounds, at $8 per ton	1 68
Green corn fodder, 280 pounds, at $2 per ton	28
Grass, 3,510 pounds, at $2 per ton	3 51
New milk, 420 pounds, at 50 cents per 100	2 10
57 nights' pasture, at 8 cents per night	4 56
Total value of food consumed	$80 41

TABLE SHOWING FORTNIGHTLY GAIN OF THE SIXTEEN CALVES, AND DAILY GAIN PER CALF DURING THE FIRST PERIOD.

Date.	Weight of lot.	Gain of lot in 14 days.	Daily gain per calf.
	lbs	lbs	lbs
June 22	1,934		
July 6	2,220	286	1.2
July 20	2,552	332	1.4
August 3	2,852	300	1.3
August 17	3,179	327	1.4
August 31	3,567	388	1.7
September 14	4,064	497	2.2
September 28	4,494	430	1.9

A total gain of 2,560 pounds in 14 weeks.

SECOND PERIOD, SEPT. 29 TO DEC. 21, 1885—12 WEEKS.

During this period the calves were weaned from milk. For a time they were out nights on pasture, but later were kept up constantly.

The following table shows the food consumed during this period:

Corn meal, 158 pounds, at $16 per ton	$1 26
Oats and corn ground, 1,140 pounds, at $18 per ton	10 26
Wheat, ground, 556 pounds, at $20 per ton	5 56
Shorts, 1,765 pounds, at $14 per ton	12 35
Bran, 679 pounds, at $12 per ton	4 07
Hay, 2,023 pounds, at $8 per ton	8 09
Corn stalks, 3,810 pounds, at $4 per ton	7 62
Ensilage, 788 pounds, at $3 per ton	1 18
Skim-milk, 1,190 pounds, at 25 cents per cwt	2 97
25 nights pasture at 8 cents	2 00
Salt (estimated) 50 pounds at ½ cent	25
Total cost of food consumed	$55 61

Table showing fortnightly gain of 16 calves, and daily gain per calf during the second period:

Date.	Weight of lot	Gain of lot in 14 days.	Daily gain per calf.
	lbs.	lbs.	lbs.
September 28	4,494	.....	.....
October 12	4,758	264	1.1
October 26	5,072	314	1.4
November 9	5,426	354	1.6
November 23	5,540	114	0.5
December 7	5,788	248	1.1
December 21	6,139	351	1.5

This shows a gain of 1,645 pounds in twelve weeks. Dividing this into the cost of the food we find we have $3.38 as the cost of 100 pounds of growth for the second period of twelve weeks.

THIRD PERIOD, DEC. 21, 1885 TO MARCH 15, 1886—12 WEEKS.

Below is given the amount and estimated cost of the food consumed during this period of twelve weeks:

Bran, 1,270 pounds, at $12 per ton	$7 62
Corn and oats, ground, 725 pounds, at $18 per ton	6 52
Corn, 591 pounds, at $16 per ton	4 72
Oats, 1,332 pounds, at $20 per ton	13 32
Shorts, 2,165 pounds, at $14 per ton	15 15
Hay, 5,370 pounds, at $8 per ton	21 48
Ensilage, 7,255 pounds, at $3 per ton	10 88
Cornstalks, 570 pounds, at $4 per ton	1 14
Salt, 72 pounds, at $10 per ton	36
Total cost of food	$81 19

Table showing fortnightly gain of 16 calves, and daily gain per calf during the third period:

Date.	Weight of lot.	Gain of lot in 14 days.	Daily gain per calf.
1885.			
	lbs.	lbs.	lbs.
December 21	6,139	.....	.....
1886.			
January 4	6,369	230	1.0
January 18	6,507	138	0.6
February 1	6,915	408	1.8
February 15	6,998	83	0.3
March 1	7,421	423	1.9
March 15	7,621	200	0.9

A total gain of 1,482 pounds in twelve weeks. Dividing this gain into the total cost of food consumed we have as the cost of 100 pounds of growth, $5.47.

FOURTH PERIOD, MARCH 16 TO APRIL 26—SIX WEEKS.

Continuing as before, but with a period of only six weeks, which carries up to time to turn into pasture, we have the following results:

Total amount of food eaten by sixteen calves in six weeks:

Bran, 1,485 lbs., at $12 per ton	$8 91
Shorts, 1,067 lbs., at $14 per ton	7 46
Corn, 1,713 lbs., at $16 per ton	13 70
Oats, 295 lbs., at $20 per ton	2 95
Cornstalks, 2,300 lbs., at $4 per ton	4 60
Hay, 1,340 lbs., at $8 per ton	5 36
Salt, 36 lbs., at $10 per ton	18
Total cost of food	$43 16

Table showing fortnightly gain of sixteen calves, and daily gain per calf for the fourth period:

Date	Weight of lot.	Gain in 14 days.	Daily gain per calf.
	lbs.	lbs.	lbs.
March 15	7,621		
March 29	7,813	192	0.8
April 12	7,993	180	0.8
April 26	8,137	144	0.6

A gain of 516 pounds in six weeks.

Dividing this gain into the cost of the food consumed, we find the cost of 100 pounds of growth during this period was $8.36.

Reviewing the results, we find the cost of gain for the several periods to be as follows:

First period, 14 weeks, 100 pounds gain, cost	$3 14
Second period, 12 weeks, 100 pounds gain, cost	3 38
Third period, 12 weeks, 100 pounds gain, cost	5 47
Fourth period, 6 weeks, 100 pounds gain, cost	8 36

It will be seen that considering the large prices allowed for the food consumed, the cost of growth during the first two periods, covering 26 weeks, is very low; on the other hand, for the third period, the cost is high, and for the last six weeks beyond all reason.

FIFTH PERIOD.

This period includes summer pasture from April 26, 1887, to November 3, when the steers were taken from pasture, and twenty-two days after they were put in the barn before the winter's experiments with them began. * * *

When turned out to pasture, April 26, the lot averaged 508 pounds apiece. Those retained weighed November 25, 795 pounds. This is after all shrinkage occurring from shutting up in the barn where, as before noted, there had been one off feed and had undergone the operation of dehorning.

If we take the gain as indicated by these figures, we have as a gain, 287 pounds, or about one and a third pounds per head per day.

To get at the cost of gain we may calculate it thus:

Pasture, 12 steers, at $8 per head	$96 00
2,200 pounds corn and bran at $15 per ton	16 50
2,800 pounds of hay at $8 per ton	11 20
Total cost of keeping for 212 days	$123 70
Gain in 212 days	3,444 lbs.
Cost per 100 lbs. gain	$3 59

SIXTH PERIOD.—NOVEMBER 25, 1886, TO JANUARY 28, 1887.

Results of Feeding Twelve Yearling Steers from November 25, 1886, to January 28, 1887.

12,162 lbs. hay, at $8 per ton	$48 64
9,975 lbs. corn and bran, at $15 per ton	74 80
Total cost of food	$123 44
Weight of twelve steers, November 25	9,546 lbs.
Weight of twelve steers, January 28	11,535 lbs.
Gain of twelve steers in sixty-five days	1,989 lbs.
Gain per steer per day	2½ lbs.
Cost for 100 lbs. gain	$6 18

A gain of two and a half pounds per day for a period of over two months. Further comment is withheld until the other periods are reported.

SEVENTH PERIOD—JANUARY 29, TO APRIL 25, 1887.

9,549 pounds hay at $8 per ton	$38 19
10,369 pounds corn and bran at $15 per ton	77 76
Total cost of food	$115 95
Weight of 10 steers January 28th	9,711 lbs.
" " " April 25th	10,435 "
Gain in 88 days	724 lbs.
Gain per steer per day	$\frac{8}{10}$ lbs.
Cost of 100 lbs. of gain	$16 01

EIGHTH PERIOD—APRIL 26, TO JUNE 21, 1887.

Value of pasture for 10 steers, two months	$33 33
Value of 3,330 pounds grain fed at $15 per ton	24 99
Total cost of feed	$58 30
Weight of 10 steers April 25th	10,435 lbs.
" " " June 21	11,146 "
Gain in 57 days	711 lbs.
Cost per 100 lbs. gain	$8 19

CONCLUSIONS FROM THE ABOVE TRIAL.

With the last period we close two years of feeding and weighing, and now we are in condition to figure up the profits or loss. Let us group our figures so as to more easily see what we have done.

SUMMARY OF TWO YEARS WORK IN FEEDING FOR BEEF, BEGINNING WITH CALVES.

Period.	Length.	No. of steers fed.	Cost of feed.	Gain.	Cost of 100 lbs.	Season.
	days.			lbs.		
1.....	98	16	$80 41	2,560	$3 14	Summer.
2.....	84	16	55 61	1,645	3 38	Fall.
3.....	84	16	81 19	1,482	5 47	Winter.
4.....	42	16	43 16	516	8 36	Spring.
5.....	212	16	123 70	3,444	3 59	Summer and fall.
6..... ..	65	12	123 44	1,989	6 18	Winter.
7.....	88	10	115 95	724	16 01	Winter.
8.....	57	10	58 30	711	8 19	Spring and summer.
Total..	730	.....	$681 76	13,071	.....	

It will be seen that we made 13,071 pounds of growth for $681.76, or one hundred pounds of growth cost $5.21 on the average for the whole period.

One hundred pounds of growth cost $4.19 during the first four periods, aggregating 308 days.

One hundred pounds of growth cost $6.13 during the last four periods, aggregating 422 days.

These figures are based on high values (for Wisconsin) of all food consumed, bran, corn meal and shorts being charged for at from $12.00 to $18.00 per ton, hay $8.00 and sweet skim milk, 25 cents per 100 pounds.

Pasture was charged up at $8.00 per head for yearlings and $10.00 for two-year olds.

RELATIVE VALUE OF FEEDING STUFFS.

[From report of New York Agricultural Experiment Station, 1884, pp. 47 to 49, Dr. E. L. Sturtevant, Director.]

100 lbs. hay was the equivalent to 145 lbs. fodder corn.
100 lbs. hay was the equivalent to 381 lbs. ensilage.
100 lbs. hay was the equivalent to 94 lbs. Soja bean fodder.
100 lbs. fodder corn was the equivalent to 262 lbs. ensilage.
100 lbs. fodder corn was the equivalent to 69 lbs. hay.
100 lbs. fodder corn was the equivalent to 65 lbs. Soja bean fodder.
100 lbs. ensilage was the equivalent to 38 lbs. fodder corn.
100 lbs. ensilage was the equivalent to 26 lbs. hay.
100 lbs. ensilage was the equivalent to 25 lbs. Soja bean fodder.

In Bulletin No. 3 of the Agricultural Experiment Station, University of Wisconsin, are the results of digestion experiments with sheep. With the exception of our digestion experiment with fodder corn and ensilage, these are, so far as we know, the first trials published in this country, and hence we incorporate the results, along with our own, in tabular form, as below:

AMERICAN DIGESTION EXPERIMENTS.

	Per cent. digested.			
	Albuminoids.	Crude fibre.	Nit. free extract.	Fat.
1. Corn fodder, milch cows, N. Y. station	49	67	61	73
2. Ensilage, milch cows, N. Y. station ..	49	69	67	90
3. Soja bean fodder, milch cows, N. Y. station	70	58	82	54
4. Meadow hay, milch cows, N. Y. station	49	49	58	50
5. Clover hay, sheep, Wisconsin station.	49	47	57	42
6. Malt sprouts, sheep, Wisconsin station	80	34	69	100
7. Cotton seed meal, sheep, Wis. station.	89	0	69	100

EXPERIMENTS WITH PIG FEEDING.

[From Ohio Agricultural Experiment Station, Report V., 1886, p. 140, by W. S. Deval, Supt. Field Experiments.]

COMPARATIVE COST OF FOOD EATEN DURING FIRST 42 AND LAST 42 DAYS OF EXPERIMENT.

		Cost of food per pig per day.....	Increase in wt. per pig per day.....	Total cost of food.....	Total increase in weight...	Am't of food to produce 1 lb. increase.	Cost of food required to produce 1 lb. increase.....
		Cts.	Lbs.	Dolls.	Lbs.	Lbs.	Cts.
Pen 1....	First period.....	6.31	1.87	7.96	238.	6.71	2.93
	Second period.....	7.93	1.20	9.99	151.75	13.21	6.45
Pen 2....	First period.....	10.76	1.90	13.56	240.	7.16	5.65
	Second period.....	11.07	1.22	14 05	153.5	13.31	9.18
Pen 3....	First period.....	20.40	2.07	17.18	174.	5.75	9.87
	Second period.....	17.20	1.15	14.15	96.5	12.24	15.05

The average for the whole time (92 days) of cost of food required to produce one pound increase in weight was:

Ration 1—Corn meal and skimmed milk.....	4.37	cents.
Ration 2—Pea meal and skimmed milk.....	7.43	"
Ration 3—Corn meal, pea meal and whole milk.....	11.42	"

FEEDING FOR FAT AND FOR LEAN.

[From Wisconsin Agricultural Experiment Station, Report IV., 1886—Prof. W. A. Henry, Director.]

THE PURPOSE OF THE EXPERIMENT.

The experiments of Prof. Sanborn of the Missouri Agricultural College as detailed in Bulletins Nos. 9, 14 and 19 of that college show that the character of the feed has a wonderful influence on the composition of the meat in the carcass of the pig.

DETAILS OF THE EXPERIMENT.

Out of a litter of eight pigs six were selected which were even in size and form, for the trial when they were 100 days old. Up to the beginning of the trial the pigs were all fed alike from the same trough a mixture consisting of shorts, corn meal, skim milk and butter milk. The pigs were one-half Jersey Red and half Poland-China in breed. At the beginning of the trial the six were divided into two lots of three each, and to Lot I. fed a ration consisting of one part dried blood, six parts shorts, fourteen parts sweet skim milk by weight. To lot II. was feed all the fine ground corn meal they could properly consume. Water was freely provided for each lot, and each had the run of a small yard back of the feeding pen in which exercise could be taken; all went on with remarkable uniformity from first to last with no accident of any kind to either lot during the whole period of 136 days.

The following shows in a condensed form the amount of food consumed by the two lots during the trial of 136 days:

LOT I.—FED FOR LEAN.	Pounds.
Amount of sweet skim milk consumed	3,302
Amount of shorts consumed	1,415 1-7
Amount of dried blood consumed	235 6-7
Weight of lot of 3 pigs, June 25	264
LOT II.—FED FOR FAT.	
Amount of corn meal consumed	1,690
Weight of lot of 3 pigs, June 25	270

The following analyses are given as representative of the constituents of the food articles used in the trial. The dried blood was analyzed with the results here given; the other analyses are taken from work done by the Station on similar products, and cannot vary enough from those actually fed to make any difference in the discussion.

CHEMICAL COMPOSITION OF FEEDING MATERIALS USED IN THE TRIAL.

	Shorts.	Skim-milk.	Corn meal.	Dried blood.
Water	15.52	90 20	15.14	17.60
Ash	4.00	0.82	1.47	3.20
Protein	16.06	3.99	10.66	76.06
Crude fibre	5.84	.00	1 99	.00
Nitrogen-free extract	53.26	4.47	67.09	3.13
Fat	5.32	0.52	3.65	0.0017

Coming now to the actual amount of food matter each lot was furnished we may state it thus by taking the average digestibility of each article:

DIGESTIBLE MATTER IN THE TWO RATIONS.

	Protein.	Carbo-hydrates.
	lbs.	lbs.
LOT I.		
3,302 lbs. sweet skim-milk	129.76	200.43
1,415 1-7 lbs. shorts	170.36	630.36
235 6-7 lbs. dried blood	128.66	2.86
Total	428.78	833.65
LOT II.		
1,690 lbs. of corn meal	153 11	*1,193.98

*The fat has been multiplied by 2.5 and added to get these figures.

Nutritive ratio, about 1 to 2 for Lot 1.
Nutritive ratio, about 1 to 7.7 for Lot II.

It will be noticed that the total amount of digestible matter fed Lot II. is in excess of that fed Lot I., but nevertheless it is mainly carbonaceous in character.

A nutritive ratio so narrow as 1 to 2 (one part protein to two of carbo-hydrates) is out of all proportion in practice, and as protein compounds are always costly in the markets, such a ration is necessarily

an expensive one. In an experiment like this, however, the question of cost of food is of secondary importance. The ratio of 1 to 7.7 is wider than the German experiments show to be best for fattening swine.

WEIGHT OF HOGS IN THE EXPERIMENT.

LOT I.—FED FOR LEAN.	Pounds.
Weight of lot of 3 pigs, June 25	264
Weight of lot of 3 pigs, November 8	669½
Gain in 136 days	405½
LOT II.—FED FOR FAT.	
Weight of lot of 3 pigs, June 25	270
Weight of lot of 3 pigs, November 8	561½
Gain in 136 days	291½

It will be seen that our protein fed pigs gained considerably faster than those fed on corn meal alone.

TABLE PRESENTING DATA OF TRIAL IN FEEDING FOR FAT AND FOR LEAN.

	Live weight.	Dressed weight.	External fat.	Lean meat.	Head.	Skin.	Brain.	Kidneys.	Spleen.	Heart.	Fat from intestines.		Weight of small intestines.		Weight of large intestines.		Length of small intestines.	
Fed for lean—	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	oz.	oz.	oz.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	ft.	in.
Lot I., No. 1	222	180½	49½	82	18	7½	5½	8½	6½	10	4	1	2	1	2	6½	59	0
Lot I., No. 2	237¼	192¼	46½	93	17	7	5½	9½	4½	11	5	9	2	3	2	14	60	4
Lot I., No. 3	210	169	54	69	14½	6	5¼	9	5	8	4	4½	2	10	3	4	65	6
Total for 3 hogs	669¼	541¾	150	244	49½	20½	16¼	27	16	29	13	14½	6	14	8	8½	184	10
Fed for fat—																		
Lot II., No. 1	168½	136	45½	50½	15	4	5½	6½	3	7½	4	12	1	14	2	15	62	0
Lot II., No. 2	188	151	55	57½	15	5	4½	6½	4	9	5	0	1	8	2	8	60	0
Lot II., No. 3	205	164	55½	70½	17½	6	4¼	6	5	10	5	7	1	14½	3	0	58	6
Total for 3 hogs	561½	451	156½	178½	47½	15	14	19	12	26½	15	3	5	4½	8	7	180	6

TABLE PRESENTING DATA OF TRIAL IN FEEDING FOR FAT AND LEAN.—CONTINUED.

	Length of large intestines		Weight of stomach		Weight of liver		Weight of lungs		Weight of blood		Weight of leaf lard		Weight of tenderloin muscles		Weight of large muscles of back		Weight of hair		Weight of bones		Breaking weight for thigh bones	
Fed for lean—	ft.	in.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz	lbs.	oz.	lbs.	oz.	lbs.	lbs.
Lot I., No. 1	16	6	1	7½	3	11	1	4½	6	....	7	8½	1	13	9	5	1	11	11	14½	1030	1090
Lot I., No. 2	16	6	1	6	2	1½	1	13	7	....	8	13	2	5½	9	13½	1	10½	12	2	840	790
Lot I., No. 3	16	....	1	3	3	5½	1	11½	5	8	10	11	1	10½	7	5	1	7	9	8½	800	....
Total for three hogs	49	0	4	½	9	2½	4	13	18	8	27	½	5	12¼	26	7½	4	12½	33	9	4550	
Fed for fat—																						
Lot II., No. 1	18	9	1	3½	1	13½	1	2½	3	9	8	5½	1	2½	4	10	1	....	9	5	645	580
Lot II., No. 2	16	9	1	6½	2	14	1	10	3	8	8	2½	1	5	6	2	1	6	8	11	600	580
Lot II., No. 3	17	....	1	7	2	2	1	6	4	9	8	9	1	7	5	5	1	2	9	4	450	....
Total for three hogs	52	6	4	1	6	13½	4	2½	11	10	25	1	3	14½	16	1	3	8	27	4	2855	

Figures packed in as these are are mainly lost to the general reader, and to aid such let us present in a more marked way some of the differences between the two lots of hogs, as shown by the tables:

1. The live weight of Lot I. is 19 per cent. greater than Lot II.

2. The dressed weight of Lot I. is 21 per cent. greater than Lot II.

These differences should be borne in mind in considering what follows:

3. The kidneys of Lot I. weighed 42 per cent. more than those of Lot II.

4. The spleens of Lot I. weighed 33 per cent. more than those of Lot II.

5. The livers of Lot I. weighed 32 per cent. more than those of Lot II.

6. The blood (caught on killing) of Lot I. weighed 59 per cent. more than that of Lot II.

7. The hair on Lot I. weighed 36 per cent. more than that of Lot II.

8. The skin of Lot I. weighed 36 per cent. more for Lot I. than for Lot II.

9. The large muscles of the back (*Ilio spinalis*) of Lot I. weighed 64 per cent. more than those of Lot II.

10. The two tenderloin muscles (*Psoas magnus*) of Lot I. weighed 38; per cent. more than those of Lot II.

11. 38 per cent. of all the meat that could be cut from the carcasses of Lot I. was fat, while the fat of Lot II. was 46 per cent. of all that could be separated.

12. The bones of Lot I. were 23 per cent. heavier than those of Lot II.

13. The thigh bones of Lot I. were 62 per cent. stronger with the testing machine than those of Lot II.

In testing the strength of the bones another remarkable exhibition of the difference in the lots was obtained. By the table it will be seen that the number of pounds pressure required to break the thigh bones the of hogs was as follows:

	Pounds strain required to break.		
	First bone.	Second bone.	
LOT I.			
Number 1	1,030	1,090	
Number 2	810	790	
Number 3	800	..... *	
Total for lot	.....	.....	4,540
LOT II.			
Number 1	645	580	
Number 2	600	580	
Number 3	450	..... *	
Total for lot	.....	.....	2,855

* A ham from the 3d hog of each lot was cut across to examine the meat, in this way one thigh bone was spoiled for this test.

That is, the average strength of the bones of Lot I. over Lot II. is 65 per cent., as shown by a machine for testing the strength of materials.

COMPOSITION AND VALUE OF FOODS.

[From the Proceedings of the American Association for the Advancement of Science, Vol. XXXIV., Ann Arbor Meeting, August, 1885, by Maj. Henry E. Alvord, Houghton Farm, Mountainville, N. Y.)

Name.	Per one hundred pounds. Protein	Carbo-Hydrates	Value	Average Market Price.	Price greater or less than value.....
Standard Cows' Milk	4.00	10.52	$3 54	$3 25 a	minus
Cows' Milk (average all kinds)	3.41	11.23	3 24	2 79 b	"
Skimmed Milk	3.06	6.15	2 63	1 77 c	"
Butter-milk	3.78	5.89	3 13	1 77 d	"
Cream	3.70	48.51	6 06	12 50	plus
Butter	0.86	146.05	10 67	25 00	"
Fat Cheese	27.16	55.78	23 46	14 00	minus
Average Ox Beef	21.39	9.08	16 32	16 32	equal
Fat Veal	18.88	13.89	14 57	15 00	plus
Fat Mutton	14.80	63.73	15 12	15 00	minus
Fat Pork	14.54	65.35	15 04	13 00	"
Domestic Fowl (fat)	18.49	17.54	14 54	16 00	plus
Hens' Eggs	12.55	21.74	10 56	10 65 e	"
Salmon	13.10	12.67	10 32	30 00	"
Mackerel	23.42	11.83	17 69	10 00	minus
Cod Fish (dried)	17.90	2.25	13 05	8 00	"
Oysters	4.95	3.27	3 97	10 00	plus
Fine Wheat Flour	8.91	76.12	3 94	3 00	minus
Fine Wheat Bread	6.82	53 69	2 83	4 00	plus
Oat Meal	15.50	74.37	4 52	3 00	minus
Potatoes	1.79	20.84	1 01	1 00	equal
Rice	1.81	76.61	3 24	6 00	plus
Beans	23.56	52.10	4 44	4 00	minus
Peas	22.63	56.25	4 51	5 00	plus
Cabbage	2.95	9.24	0 66	1 00	"
Onions (red)	1.68	10.99	0 61	2 00	"
Tomatoes	1.25	4.66	0 31	2 00	"
Cane Sugar	0.35	96.73	3 90	6 00	"
Honey	1.29	81.43	3 39	25 00	"
Apples	0.39	13.74	0 59		"
Peaches	0.65	12.57	0 57		"
Grapes	0.59	17.11	0 74		"
Strawberries	1.07	8.48	0 45		"
Dried Apples	1.06	55.97	2 35		"

NOTES:—a, 7c. per qt.; b, 6c. per qt.; c, 4c. per qt.; d, 4c. per qt.; e, 16c. per dozen.

COMPARATIVE WEIGHT OF DIFFERENT PARTS OF PIGS.

[From Ohio Agricultural Experiment Station, Report V., 1886, p. 144.]

PER CENT. OF CARCASS CONTAINED IN EACH PART.

Pig number.	Hams.	Shoulders.	Sides.	Ribs and back.	Head.	Feet.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
3	19.26	20.65	38.05	6.09	6.96	1.86
6	22.02	21.76	37.56	5.25	8.29	1.94
8	19.04	24.84	35.71	5.31	8.99	1.50

The variation in weight of the different parts was slight in the different pigs. The difference in the per cent. of fat and lean meat in each is greater.

PIG FEEDING.—TABLE XI.—PER CENTS OF FAT AND LEAN IN HAM, SHOULDER AND SIDE.

Pig Number.	Fat.				Lean.			
	Ham.....	Shoulder..	Side.....	Average..	Ham.....	Shoulder..	Side.....	Average..
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
No. 3.....	36 1	32.6	65.9	44.9	63.9	67.4	34.1	55.1
No. 6.....	38.2	38.1	71.0	49.1	61.8	61.9	29.0	50.9
No. 8.....	43 9	49.5	74.1	53.8	56.1	50.5	25.9	44.2

DAIRYING.

INFLUENCE OF DISTANCE FROM CALVING ON MILK YIELD.

[From New York Agricultural Experiment Station V., 1886, pp. 21 to 23, Dr. E. L. Sturtevant, Director.]

In experimenting upon the feeding of milch cows it is often necessary to be able to calculate the extent to which the flow may decrease under the influence of distance from calving. For the purpose of investigating this question we have gone over the milk records of the Waushakum farm herd, South Farmingham, Mass., as kept by the Sturtevant Bros., from December, 1866, to December, 1881, inclusive, and have arranged the milk yields of each cow for each thirty days from calving. These records are:

For 35 different native cows, and 59 calvings.

For 45 different Ayrshire cows, and 145 calvings.

For 3 different Jersey cows, and 6 calvings.

While the natives were kept, the feeding was liberal, yield being the objective point, regardless of the calves. While the Ayrshire cows were maintained, the feeding was lower, as befitted a breeding herd, and the records embrace the yield of many young animals in their first year of milk. For the whole herd, during the fifteen years, the calvings were quite well distributed over the year, no particular season for calving being desired, as the milk was disposed of at retail during much of the time.

We give a table of our results under two heads; the first embraces every cow, farrows as well as those in regular calvings, and cows which only remained a few months in the herd. The second embraces only those cows which went dry betwen the eighth and twelfth month from calving.

TABLE I.

Month from calving.	For whole herd. No. of monthly records.	For whole herd. Average yield per month.
		lbs.
1	210	771
2	206	731
3	197	659
4	195	597
5	191	518
6	183	405
7	175	448
8	153	403
9	119	370
10	93	334
11	60	317
12	38	326
13	26	349
14	19	358
15	15	366
16	13	319
17	10	316
18	9	308
19	6	306
20	4	302
21	4	243
22	3	271
23	2	284
24	2	238

TABLE II.

For cows that went dry between 8th and 12th month. No. of monthly records.	For cows that went dry between 8th and 12th month. Average yield per month.
	lbs.
121	808
121	757
121	685
121	617
121	560
121	511
121	451
121	380
88	348
63	312
34	254
13	223

If we examine the differences between the yields of successive periods, we do not perceive much uniformity. Yet if we calculate the average daily yield during each period, and estimate the falling off by percentages, we may note that the apparent decrease is about nine per cent. of the yield for a preceding period; or the same percentage may be calculated on the total yields. We will place in one column the actual results tabulated, and alongside the yield of each period decreased by nine per cent., and this we will call the theoretical yield.

FOR THE WHOLE HERD.

	Actual daily milk yield, lbs.....	Theoretical daily milk yield, lbs.	Actual yield per month, lbs	Theoretical yield per month, lbs
1st month.....	25.7	25.7	771	771
2d "	24.4	23.4	731	702
3d "	22.0	21.3	659	639
4th "	19.9	19.4	597	582
5th "	17.3	17.7	518	530
6th "	16.5	16.1	495	483
7th "	14.9	14.7	448	440
8th "	13.4	13.4	403	401
9th "	12.3	12.2	370	365
10th "	11.1	11.1	334	333

FOR THE COWS THAT WENT DRY BETWEEN 8TH AND 12TH MONTH.

	Actual daily milk yield, lbs	Theoretical daily milk yield, lbs..	Actual yield per month, lbs.....	Theoretical yield per month, lbs
1st month.....	26.9	26.9	808	808
2d "	25 2	24.5	757	736
3d "	22.8	22.3	685	670
4th "	20.6	21.3	617	610
5th "	18.7	18.5	560	555
6th "	17.0	16.9	511	504
7th "	15.0	15.4	451	459
8th "	12.7	14.0	380	418
9th "	11.6	12 8	348	381
10th "	10.4	11.6	312	346

We therefore believe that the natural falling off in milk for each month from calving, is about nine per cent. of the yield of the preceding month.

VALUE OF AN ACRE OF FODDER TURNED INTO BUTTER.

[From Agricultural Experiment Station of Wisconsin, IV., 1886, page 44, Prof. W. A. Henry, Director.]

Let us calculate the value of our fodder crop in units of butter:

The average of four trials with us shows it requires 2,450 pounds of corn fodder, cut fine, together with 750 pounds of bran and 450

pounds of corn meal to make 100 pounds of butter. 12,250 pounds of fodder corn per acre is not more than a good yield with good cultivation and with soil in Wisconsin, and is just the amount actually obtained by us, as reported. We have fodder enough, then, for 500 pounds of butter on one acre of land. To go with this fodder to make this 500 pounds of butter we would need 3,750 pounds of bran and 2,250 pounds of corn meal or three tons in all, worth say $15 per ton, or $45.

We see, then, that with one acre of fodder corn, cut fine, and $45 worth of feed, we have the material to make 500 pounds of butter. This, of course, applies only to good cows, those capable of making from 250 to 300 pounds of butter a year. These figures may be doubted, but I ask a careful study of all the figures given, and believe the correctness of the statement will be more and more clear as one ponders over the facts given.

The truth of the matter is, we do not half appreciate the value of the Indian corn crop. The silo has been the means of opening the eyes of many to see its possibilities. Not wishing to detract one iota from the value and importance of the silo, I cannot but affirm that most of the credit given it by many is due rather to the grand corn crop put into it.

EXPERIMENTS IN SETTING MILK.

[From Wisconsin Agricultural Experiment Station, II., 1884, pages 20-21, Prof. W. A. Henry, Director.]

At the Experimental Farm the milk is strained immediately upon milking into Cooley cans which are 8 1-2 inches in diameter and 20 inches deep, and these cans containing the warm milk are plunged into water with ice floating on it. Noticing that the dairyman was not always prompt in placing the cans of milk in the water, I thought it wise to test and see if any loss resulted from the delay.

Number.	Amount of milk set	Temperature of the atmosphere.	Time lot II. stood in open air.....	Temperature of milk when set..	Amount of butter churned.....		Per cent. of loss from delaying the setting.....
	lbs.	F'ht.	Min	F'ht.	lbs.	oz.	
I	52	.....	.....	91 deg.	2	12	.....
II	52	19 deg.	20	86 deg.	2	9½	5.7
I	41	.....	.....	91 deg.	2	5	.....
II	41	30 deg	25	80 deg	2	1½	9.4
I	51	.....	.....	93 deg.	2	13	.....
II	51	28 deg	25	86 deg.	2	11	4.4
I	51	.....	.....	91 deg.	2	6½	.....
II	51	28 deg.	30	78 deg.	2	4½	5.2
I	50	.....	.....	93 deg.	3	1	.....
II	50	.....	30	82 deg.	2	13	8.1

It will be seen that the loss runs from four to more than nine per cent. of the butter made. This is quite significant and points clearly that to avoid loss the cans of milk should go to the water tank at once. Of course no dairyman would think of allowing cans of milk ordinarily to stand so long as they did in these trials, yet in the hurry to get to breakfast they are apt to be overlooked occasionally.

BARN-YARD MANURE.

AMOUNT OF EXCREMENT PASSED DAILY BY COWS.

[From Director's Report New York Agricultural Experiment Station V., 1886, pp. 19-20].

The figures gained from our experiments of 1883 and 1884 show that this amount is very variable. We indicate the conditions and the amount in the following table:

1883—AVERAGE OF FOUR COWS.

	Weight of cows.	Ration.	Average weight of ration.	Average weight of excrement.
	lbs.		lbs.	lbs.
January 5-7.....	709	Hay, meal, shorts.....	24.9	57.1
January 12-14....	720	Hay, shorts.....	23.9	58.5
January 17-19....	712	Hay, gluten meal.....	21.0	43.4
January 23-25....	705	Hay, meal	20.8	43.4
February 1-3....	678	Hay, meal, ensilage.....	33.9	29.6
February 9-11...	705	Hay, ensilage	57.7	40.5
February 15-17..	685	Hay, meal, shorts.....	20.8	47.1

1884—AVERAGE OF TWO COWS.

	Weight of cows.....	Ration.	Av. weight of ration.....	Av. weight of excrement.	The excrement was:	
					Dung.	Urine.
	lbs.		lbs.	lbs.	lbs.	lbs.
Jan. 21-24....	728	Corn fodder, meal, shorts	34.6	51.1	39.7	11.4
Feb. 4-7.....	747	Ensilage, meal, shorts....	78.0	47.1	33.8	13.3
Feb. 16.....	725	Soja bean, meal, shorts...	25.3	40.8	29.8	11.0
Feb. 26-29....	718	Hay, meal, shorts.....	26.3	54.2	45.5	8.7
March 10-12..	715	Hay, meal, shorts, potatoes	61.4	63.3	42.5	20.8

We observe that for cows of from 678 to 747 pounds weight, under various kinds of food, the total excrement passed varied from about 30 to 63 pounds daily. Under the like feed, hay, meal and shorts, in about the customary proportion in good feeding, the excrement weighed 57, 47 and 54 pounds; under hay, grain and ensilage feeding the excrement voided figured up 30 and 47 pounds. We observe, however, that there is an increase of excrement whenever shorts are fed. Thus selecting the periods when dry feed was used, in six periods when shorts were

used the excrement varied from 41 to 58 pounds daily; when no shorts were used 43.4 pounds in each of the two periods; in the one period when shorts alone were fed, the maximum amount of excrement was noted.

The average amount of excrement voided by the animals during the above periods was 48 pounds daily; the daily average for 110 days was 48.5 pounds.

During the winter season a stabled cow may be assumed to supply about 48 pounds × 30 days = 1,440 pounds of manure per month.

The dry matter in the food and the excrement in the above periods was:

1883—Average of four cows.		1884—Average of two cows.	
Dry food consumed.	Excrement.	Dry food consumed	Excrement.
21.2	51.7	18.7	51.1
20.5	58.5	17.2	47.1
18.8	43.4	20.1	40.8
17 3	43.4	19.0	54.2
9.6	29.6	17.3	63.3
12.3	40.5		
17.7	47.1		

The average relation is, therefore, in 1883, the excrement 2.7 times the weight of the dry food; in 1884, 2.7 times the weight of the dry food. We may, therefore, assume that in practical feeding we cannot be far wrong when we estimate that the excremate amounts to about two and a half times the weight of hay and grain fed.

COST AND VALUE OF STABLE MANURE.

[From Prof. I. P. Robert's Experiments at Cornell University, III., 1883-4 and 1884-5, pp. 7 to 10.

For two successive seasons an attempt has been made to determine the value of this stock of home-made manure, in the same manner, and on the same basis, that the valuation of a sample of a commericial fertilizer is estimated. The accumulated layer of mixed manure of cattle and horses was at the end of the first season about two feet thick, and packed quite solid by the tramping of the cattle

over it. A large number of samples of about ten pounds each were taken at the depth of about a foot, chopped up and most carefully mixed together, and a sample of this mixture was analyzed with the following results:

Moisture	72.95 per cent.
Nitrogen	0.78 "
Phosphoric acid	0.4 "
Potash	0.84 "

Allowing for the nitrogen a commercial value of 15 cents a pound, for the phosphoric acid 7 cents, and for the potash 4.25 cents, we have the following estimate of the value of a ton of the manure:

Nitrogen	0.78	2000	15	$2.34
Phosphoric acid	0.4	2000	7	.56
Potash	0.84	2000	4.25	.71
Total				$3.61

Of this manure 311 loads was produced in the course of the season; about every tenth load was weighed, and the average weight was estimated to be very nearly 3,000 pounds. Hence the total quantity produced was at least 466 tons, which at $3.61 per ton would have a trade value of very nearly $1,682; that is to say, it would have cost this sum to have purchased the same quantity of nitrogen, phosphoric acid and potash, of about the same degree of assimmilability in commercial fertilizers.

The investigations of this season were not fully satisfactory, because all the manure was not weighed, and the number and kind of animals were not noted from month to month; this number was, however, about forty-five.

In the second season, 1884–5, these data were all carefully taken. In five months, from October 1 to March 2, 199.25 tons of manure were produced by a herd of twelve spring calves, seven winter calves, one bull, twenty-four cows, twelve horses and one colt, making fifty-seven animals in all; allowing that the twenty young animals would equal ten adults, we would have the equivalent of forty-seven full grown animals.

The manure was sampled in the same manner as described above, and the analysis was made by Mr. A. M. Breed, a senior in the course in agriculture, with the following results:

Moisture	75.57	per cent.
Nitrogen	0.68	"
Phosphoric acid	0.29	"
Potash	0.7	"

As less cottonseed meal was fed this season than last, it was expected that the manure would not be so rich as then, and the expectation was confirmed by the results of the analysis.

The trade value of these three nutrients in a ton of this manure, computed as before would be:

Nitrogen	0.68	2000	15	$2.04
Phosphoric acid	0.29	2000	7	.41
Potash	0.7	2000	4.25	.60
Total				$3.05

Calling the total quantity of manure produced 200 tons, as we may without seriously affecting the computation, the nitrogen, phosphoric acid and potash in this year's product of manure would cost in the fertilizer market, at current rates in 1884–5, $610.

In all probability we shall not get returns in crops equal in value to these estimated values of the stable manure spread on our fields from our manure yard; but, nevertheless, the land to which this manure has been applied has steadily increased in fertility, while at the same time producing crops whose value was more than twice as great as that of the crops yielded by the same land treated with manure made in the old style.

From experiments to be mentioned in another part of this report we have estimated that the manure from a milch cow was worth sixteen cents per day. Taking this as a fair sample of the herd, we make the following computation of the value of the manure of the first season in another way. As near as can be estimated, 80 tons of straw were used for bedding, the manure from which is estimated at $3.50 per ton; hence, for the herd of 45 animals, for 195 days:

45	195	16	$1,404 00
80	$3.50		280 00
		Total	$1,684 00

The result is very close to that obtained by the other methods of computation.

That the quantity of manure obtained in the first year is not excessively large, as it might seem to be, appears from the results of a computation by Boussingault. He estimated that a horse weighing 900 pounds and a cow (weight not given) would produce in a year the following quantities of liquid and solid manure:

Horse, liquid	12000 lbs.
" solid	3000 "
Cow, liquid	20000 "
" solid	8000 "

On this basis, a computation for six and a half months would give for twelve horses 48.75 tons, and thirty-three cattle 250.25 tons; these amounts, together with 80 tons of bedding, would make a total of 379 tons. The animals kept on our farm are without doubt above the average in weight, and would consequently yield a larger quantity of manure.

COMPARATIVE AGES BY OCCUPATIONS.

[From Forty-fifth Annual Registration Report of Commonwealth of Mass., 1886, page 40, S. W. Abbott, M. D., Editor.]

Distinguishing by Occupations (statistically classified) the Number, with their Average and Aggregate Ages, of Persons in the State (in two geographical divisions whose Occupations were specified, and whose deaths were registered, during the year 1886; also in the State (entire) during the period of Forty-three Years and Eight Months, ending with December 31, 1886. [This table includes only persons over twenty years of age.]

Occupations.	Nine Eastern Counties. 1886.			Five Western Counties. 1886.			Whole State. Forty-three years and eight months. From May 1, 1843, to Dec. 31, 1886.		
	Number of Persons.	Ages.		Number of Persons.	Ages.		Number of Persons.	Ages.	
		Aggregate.	Average.		Aggregate.	Average.		Aggregate.	Average.
All classes and occupations	6,583	346,119	52.59	2,302	128,727	58.91	238,792	12,387,499	51.87
I. Cultivators of earth.	668	47,029	70.40	661	45,173	68.34	47,511	3,153,456	66.37
II. Active Mech. abroad	549	32,206	58 66	122	7,346	60.11	18,042	983,568	54.52
III. Active Mech in shop	951	36,741	49.15	342	17 508	51.19	29,501	1,440,908	48.84
IV. Inact. Mech. in shop.	869	41,796	48.10	249	12,209	49.03	29,577	1,346,883	45.54
V. Lab. No special trade	1,312	68,276	52.04	398	21,106	53.71	45,426	2,234,249	49.18
VI. Factors lab'ng abro'd	345	15,967	46.28	95	4.580	48.21	11,216	444,661	39 65
VII. Employed on ocean.	324	17,854	55.11	4	232	58.00	12,722	620,026	48.74
VIII. Merchants, Financiers, Agents, etc....	1,043	52,024	49.88	210	10,947	52 13	28.351	1,407,421	49.64
IX. Professional Men....	246	13,299	54.06	65	3,680	56.62	8,627	449,981	52.16
X. Females.....	276	10,927	39.59	156	5,946	38.12	7,819	306,346	39.18

EXAMINATION OF WOOL.

Synopsis of recent report by the United States Department of Agriculture on examination of wools and other animal fibres prepared by Geo. H. Wallace, Esq., President Missouri State Wool Growers' Association, Fayette, Mo., together with notes by him.

Up to the time of receiving your note requesting me to prepare the synopsis with notes herewith appended, I had given the report but a cursory examination. Since then I have given it such study as time permitted, and submit the following, premising with a few statistics from the State Auditor's reports of 1881–82, and that of 1885–86, showing the condition of the sheep-breeding and wool-growing industries of the State, as returned upon the Assessor's books for taxation:

Number of sheep, 1881	1,687,290
Number of sheep, 1885	1,147,948
Decrease	539,342
Valuation of sheep, 1881	$2,348,521
Valuation of sheep, 1885	1,160,902
Decrease	$1,187,619

A decrease of nearly 32 per cent. in number and a little over 50 per cent. in value in four years.

A glance at these figures will convince every well-wisher of the State that it is a *duty* to do all and everything that may be done, to foster and preserve this industry, which heretofore has aided so much to add to the wealth, the contentment and happiness of the people. My hope is that this synopsis may aid the good work.

The "Report Upon An Examination Of Wools And Other Animal Fibres," made under the direction of the Honorable Commissioner of

Agriculture, by Prof. Wm. McMurtrie, E. M., Ph. D., University of Illinois, is the most thorough and full exhibit of the subject from a scientific standpoint, which has ever been made, and contains information for the consumer, the manufacturer, and especially the wool-grower, which has long been sought for.

The honor of originating the "International Exhibition of Sheep and Wool," held in the main exhibition building of the Centennial Exposition in Fairmount Park, in Philadelphia, Pa., lies with the Pennsylvania State Board of Agriculture, who endeavored thus to repair the omission of the Universal International Exhibition Commission of 1876, which omission had occasioned great dissatisfaction among the sheep-breeders and wool-growers of the country.

The scope of the proposed exhibition was soon found to be beyond the powers of the State Board, and an appeal was made to the National Congress to provide the necessary legislation and to "authorize and direct the Commissioner of Agriculture to attend the exhibition in person or by deputy, and make a full and complete report of the same." In answer to this a law was enacted, approved April 1, 1880, giving the requisite authority and direction.

Under this law the Commissioner appointed the following as additional members of the committee having the exhibition in charge: William G. Markham of Avon, N. Y.; E. J. Hiatt, Chester Hill, Ohio; Hon. James T. Earle, Centreville, Md.; John L. Hays, Boston, Mass.; John J. B. Killebrew, Nashville, Tenn.; C. P. Mattox, Portland, Me.; Henry C. Kelsey, Trenton, N. J.; Albert Chapman, Middleburg, Vt.; F. W. Sharper, San Diego, Tex.; Hon. Henry G. Davis, Piedmont, W. Va.; J. T. Megibbin, Cyntteiana, Ky.; Daniel Kelly, Wheaton, Ill.; Hon. Thomas Pollard, Richmond, Va.; J. S. Stanger, Denver, Col.; Benjamin Flint, San Juan, Cal.; Samuel Archer, Kansas City, Mo.; Charles R. Gibbs, Whitewater, Wis.; J. P. Sanborn, Port Huron, Mich.; Hon. David Blaine, Toronto, Ontario, and Hon. Edward A. Bernard, Quebec, under whose care the exhibition was officially opened at 12 o'clock noon, on Tuesday, September 21, 1880.

The breeds represented were the Merino, Southdown, Oxford-down, Hampshiredown, Lincoln, Shropshiredown and Cotswold, and included 366 animals.

The report of the judges appointed to decide upon the merits of these animals shows much painstaking care; but they were obliged to report that their efforts to secure information in the greatest detail in regard to breeding, care, feed, soil (whether clay, limestone. sand or slate), climate, topography, latitude, altitude above sea level, etc., were only partially successful, resulting from the fact "that so few of

our American breeders keep carefully written records of the conditions of breeding and management beyond a register of pedigree." Here is a point for American breeders to note, as there is no doubt but that these various causes have their effect upon the constitution and character of the animal and the wool grown thereon.

The following table was constructed showing the comparative weights of the animals and the average weight of fleece yielded by each breed, expressed in percentages of weights of animals:

TABLE NO. I.

Breeds.	Weight of rams.	Weight of ewes.	Average weight of fleece in per cent. of weights of carcasses.	
	Pounds.	Ponnds.	Rams.	Ewes.
Merino	92 to 146	64 to 99	19.	17.
Southdown	154 to 246	149 to 182	6.6	6.6
Oxforddown	233 to 318	175 to 248	5.	.....
Shropshiredown	124 to 176	.....	8.	.....
Cotswold	161 to 245	150 to 155	7.3	8.3
Lincoln	134 to 250	100 to 172	5.3	5.5

This table shows, to a limited extent at least, the comparative value of the several breeds for the production of both mutton and wool, but if to this could have been added the cost of production in the way of feed, care, etc., it would have been much more valuable.

Thirty-two photographs of as many different animals, secured by the instantanous process, are skillfully reproduced in this report, and are valuable as furnishing types of the different breeds, one of the most striking of which is that of the three-year old Cotswold ram exhibited by Abner Strawn of Illinois. The measurements of this animal are given as follows: length, four feet four inches; shoulder girth, four feet eleven inches; flank girth, four feet seven and one-half inches; weight, 300 pounds, and he looks every way worthy of the first premium of $100, which was awarded him.

The Oxforddown ram, "Prince of the West," and the one year old Southdown ram, exhibited by T. S. Cooper, of Pennsylvania, seems to leave nothing more to be desired for perfection in their breeds.

An act of Congress, approved June 16, 1880, provided for "testing by scientific examination the textile strength, felting capacity and other peculiarities of the different wools and other animal fibres on exhibition at the International Sheep and Wool Exhibition." This was considered to apply to wool from animals exhibited as well as that included in bales or fleeces. From the fleeces and bales single samples were taken, but from the animals, concerning which it was possible to secure fuller information with reference to the conditions influencing the production of wool, four samples were taken, and these were cut as nearly as possible from the same parts of the shoulder, side, hip and belly respectively, in some cases also, in which the skin of the Merino was greatly folded, from the tops of the folds or wrinkles and from between them. Material was thus secured for the determination of the fineness of the fibre in each part, a matter that has been the subject of considerable controversy.

Samples were also obtained from the Wells & Dickinson flock of 1828–9, and from Australia, Hungary, Russia, Spain, France, Argentine Republic, Asia Minor, Canada and elsewhere, as well as the commercial grades of Boston, Philadelphia and Germany, and it is probable that no more complete collection was ever made.

New and special apparatus was devised and obtained and the examination begun by an investigation into "the minute structure and external form of the fibres," which is fully described in Chapter III., and illustrated by 30 plates. From it we learn that wool fibre is composed of two parts, first, the epidermis or outer covering completely surrounding the fibro-cellular portion of the fibre and consists of very transparent, thin, (having, according to Naltinsias, a thickness of only 0.0014 millimeter) flat epithelial scales, lying across the spindle shaped cells within. These scales are either joined at their edges, or they overlap like shingles, the latter giving the dentate appearance characteristic of certain breeds. They are differently arranged in different races of animals and even in different breeds of sheep. In some we find the scales alternately arranged without overlapping at the edge, while in others, as the Merino, they seem to form annular layers around the whole fibre and appear like cones inserted within each other. This difference is sufficiently marked to distinguish between the two great classes into which wools are naturally divided, and might be employed, together with other markings, by breeders for the determination of the purity of the blood of any breed operated upon.

The influence of blood upon the form of these scales is prominently illustrated in the wool of the Oxforddown breed, a breed well known to have arisen from a cross between the Cotswold and one of

the Downs, and the pertinacity of these distinct forms is especially marked in the crosses between the long-wooled breeds and the Merino. Here we find both forms in the same fleece in varying proportions, depending much upon the grade of the animal.

One other marked characteristic which was found almost peculiar to the Cotswold breed is the "pigment canal" running through the fibre and detracting from its lustre.

One cannot avoid being struck with the lack of *uniformity* in the diameter of the fibre throughout its length, and this property is probably one of the most important in the determination of the commercial and industrial value of the staple. No opportunity is offered for the determination of the causes of this, but there can be little doubt that bad nutrition, exposure and consequent impaired health or constitution are the more prominent.

None of the fibres were found to have the true cylindrical form, but the long wools were more nearly so than the short fine wools.

Chapter IV. treats of "length, crimp and fineness," and after giving a very interesting account of the methods employed, actual measurements are given, and the uniformity of results upon page after page are such as to fully justify a belief in their accuracy. From them we learn that, generally speaking, the grader of wools is right in assorting, to place that from the belly as first in fineness, next to which is the shoulder, then the side and lastly the hip; and also with reference to the crimp, the greater the number of crimps to the inch, the finer the fibre.

The German authority, Bohn, gives the following as a table whereby to determine the fineness by the number of crimps:

TABLE NO. 2.

Number of crimps to the inch.	Measurements of fineness.	
	In centemilli-meters.	In fractions of an inch.
13	3.700	1-686
13 to 16	3.700 to 3.175	1-686 to 1-799
16 to 17	3.175 to 2.900	1-799 to 1-875
17 to 19	2.900 to 2.666	1-875 to 1-952
19 to 20	2.666 to 2.540	1-952 to 1-999
20 to 21	2.544 to 2.400	1-999 to 1-1058
21 to 23	2.400 to 2.225	1-1058 to 1-1141
23 to 24	2.225 to 2.030	1-1141 to 1-1267
24 to 26	2.030 to 1.900	1-1267 to 1-1336
26 to 28	1.900 to 1.775	1-1336 to 1-1430
28 to 30	1.775 to 1.650	1-1430 to 1-1587
30 to 32	1.650 to 1.500	1-1587 to 1-1693
33 and upward	1.500 to 1.250	1-1693 to 1-2031

Which is found to be nearly correct, according to the results of thousands of measurements recorded here. On page 211 the general averages of fineness to crimps are given as follows:

TABLE NO. 3.

Name of breed.	Sex.....	No. of crimps to the inch.	Measurements of fineness.	
			Centimilli-meters.	Fractions of an inch.
Southdown.....	Ram.	12	3.229	1-786
"	Ewe.	12	3.072	1-826
"	"	14	2.793	1-909
Merino.....	Ram.	14	2.469	1-1028
"	"	16	2.235	1-1136
"	"	20	2.168	1-1171
"	"	22	1.856	1-1368
"	"	25	1.794	1-1415
"	"	26	1.704	1-1490
"	Ewe.	14	2.232	1-1137
"	"	16	2.256	1-1125
"	"	20	2.105	1-1206
"	"	22	2.049	1-1239
"	"	25	1.890	1-1343
"	"	30	1.571	1-1616

We also find the Merino stands first as to fineness, and to some extent the fineness varies with the length of the fibre, the long wools being the coarser, the general averages for the different breeds being as follows:

TABLE NO. 4.

Name of breed.	Average diameter of fibre in	
	Centimilli-meters.	Fractions of an inch.
Merino	2.127	1-1194
Southdown	2.936	1-865
Hampshiredown	3.298	1-769
Lincoln	3.707	1-685
Leicester	3.879	1-654
Cotswold	4.196	1-605
Oxforddown	4.365	1-581

In the Merinos and Downs the ewe's wool is generally finer than that of the ram's, while in the Cotswold and Lincoln the rams appear to bear the finer staple, as is amply illustrated by the following statement:

TABLE NO. 5.

Name of breed.	Average diameter of fibre of			
	Rams		Ewes	
	In centimilli-meters.	In fractions of an inch.	In centimilli-meters.	In fractions of an inch.
Cotswold	4.227	1-600	4.252	1-597
Lincoln	3.671	1-691	3.774	1-672
Southdown	2.940	1-863	2.904	1-874
Oxforddown	4.269	1-594	4.241	1-598
Merino	2.215	1-1146	2.084	1-1218

The Oxforddown wool is coarser than either of the two breeds from which it sprang, thus showing the influence of the cross in the development of strength and vigor.

In table VI. of the report the results are collected to show the influence of age upon the fineness of the fibre, and while it appears

as a general rule that the diameter of the fibre increases with the age of the animal, this increase is more regular and uniform in the coarse wool breeds, than in the Merinos, and in the ram than in the ewe.

Tables VIII., IX. and X. show the effect of the wrinkles or folds upon the fineness of the fibre. Some breeders have persistently held that there was no difference in the fineness of the fibre grown upon the folds and that grown between them, but the results here given directly contradict such statements. Table No. 6 gives the measurements for diameter of the fibre on top of the folds and between the folds, for those on the shoulders and hips, and averages for the whole fleece for both rams and ewes.

TABLE NO. 6.

MERINO RAMS.

Portion of fleece.	Crimps to the inch.	Measurement of fibre	
		In centimilli-meters.	In fractions of an inch.
Shoulder—top of fold	14⅜	2.370	1-1071
Shoulder—between fold	18⅜	2.042	1-1243
Hip—top of fold	14⅜	2.611	1-972
Hip—between fold	16½	2.125	1-1195
Whole fleece—top of fold	14⅞	2.556	1-993
Whole fleece—between fold	17¼	2.137	1-1189
MERINO EWE.			
Shoulder—top of fold	16	2.311	1-1098
Shoulder—between fold	20	2.064	1-1230
Hip—top of fold	16	2.499	1-1016
Hip—between fold	20	2.171	1-1169
Whole fleece—top of fold	16	2.402	1-1057
Whole fleece—between fold	20	2.137	1-1188

It will be seen from these tables that the number of crimps to the inch, as well as the measurements of the samples, show that the fibre is from 1-6 to 1-8 finer between the folds than on the top, and Prof. McMurtrie reports that he found the wool much more dense and the

fibres longer between the folds than upon them, and argues, therefore, "that it will be as well, as a general rule, for breeders to abandon the development of wrinkles." Many breeders will differ with him in this deduction, believing, as they do, that other important qualities are secured by the development of the fold. However, we have here correct data, and granting these breeders are right, there is opportunity and demand for careful experiment, close observation and precise calculation, to determine whether the advantages secured are sufficient to offset this inequality of the fibre thus produced.

Chapter V. treats of "Tensile strength, ductility and elasticity." By "tensile strength" is meant, the strain which the fibre is able to resist previous to rupture. By "ductility" the elongation which the fibre suffers previous to rupture when subject to strain, and this may be divided into *elongation* and *set*, the former indicates the total elongation the fibre undergoes when under the influence of strain, and set, the elongation of the fibre which remains permanent when the power causing the strain is removed, the difference between elongation and set may be called *elacticity.*

It is upon these different qualities, that the commercial and industrial value of the fibre depends, more than perhaps any other. The tables of experiments and measurements under this heading, show the same pains-taking care and effort to be exact, as is found elsewhere, and they will prove of great interest to those for whom they were made, but for a full sense of results, we must understand how they were obtained, but it would be impossible within the limits of this article, to to give in detail, a description of the mode of procedure; let it suffice to say here, that every precaution that could be thought of was taken to be exact, and thirty fibres of each sample were tested, securing thus as nearly an average as could be had.

It was found as a general result, that the total stretch each fibre is able to sustain previous to breaking is a fair indication of its elasticity, or the *set* and elasticity vary almost directly with the stretch.

The tests were made of wool from the various parts of the fleece and may be summarized as follows:

TABLE NO. 7.

General averages showing influence of breed, sex and portion of fleece, upon strain and stretch.

Breeds.	Sex.	Portion of fleece.	Strain in grains.	Stretch in per cent. of length.
Cotswold.	Ram.	Shoulder	329.08	32.90
		Side	514.59	32.65
		Hip	596.24	38.80
		Whole	473.69	36.67
	Ewe.	Shoulder	496.38	33.90
		Side	526.01	33.75
		Hip	568.46	38.15
		Whole	478.47	34.75
Lincoln.	Ram.	Shoulder	414.73	34.90
		Side	361.48	37.60
		Hip	530.95	35.80
		Whole	375.06	32.60
	Ewe.	Shoulder	367.65	37.00
		Side	488.66	41.45
		Hip	499.31	39.10
		Whole	409.94	37.20
Southdown.	Ram.	Shoulder	192.31	15.30
		Side	179.04	30.25
		Hip	206.98	31.65
		Whole	178.42	20.35
	Ewe.	Shoulber	193.09	26.05
		Side	191.08	28.65
		Hip	260.54	22.70
		Whole	207.60	24.49
Oxforddown.	Ram.	Shoulder	467.36	30.65
		Side	442.82	39.35
		Hip	474.31	30.80
		Whole	461.49	34.10
	Ewe.	Shoulder	492.98	20.10
		Side	478.32	37.36
		Hip	510.58	30.55
		Whole	493.91	31.30

TABLE NO. 7.—CONTINUED.

Breeds.	Sex.	Portion of fleece.	Strain in grains.	Stretch in per cent. of length.
Merino.	Ram.	Neck	175.96	27.30
		Shoulder	103.88	26.85
		Side	97.08	29.15
		Hip	136.29	21.75
		Whole	115.30	25.50
	Ewe.	Neck	132.58	26.15
		Shoulder	95.08	27.20
		Side	89.21	30.80
		Hip	122.24	22.35
		Whole	99.09	26.05
Cotswold and Leicester			350.98	34.60
Cotswold and Southdown			181.82	17.20
½ Cotswold and ½ Merino			115.45	27.05
½ Leicester ½ Merino			121.62	16.10
Cotswold and Merino			103.26	25.25

From these tables it will be seen that while the Cotswold, Oxforddown and other coarse wools have a high stretch with a high strain, relatively the stretch of the Merino is much higher when compared with the strain, and also that in all breeds, with the exception of the Merino, the ewes' wool is stronger and is able to sustain a greater strain than the rams' wool. In the wools of the cross-bred animals, there seems to have been no improvement in either strength or stretch as a result of the cross, for in all cases both strain and stretch are lower than in the original breeds of either side.

Thus we find the different breeds vary greatly in these various qualities of their wool, and for comparison the following table of general averages of all measurements is given, the last column being added to show the strength of each, with the fibres reduced to 4 centi-millimeters or 1-634 of an inch:

TABLE NO. 8.

Name of Breed.	Fineness.		Stretch in per ct. of length.....	Strain in Grains.	
	In centimillimeters...	In fractions of an inch.		Average natural diameter....	Reduced to same diameter of 1-634 of an inch.
Cotswold	4.196	1-605	35.45	469.83	426.90
Oxforddown	4.365	1-581	33.05	469.67	394.35
Leicester	3.879	1-654	28.05	365.80	388.90
Lincoln	3.707	1-685	35.35	396.05	461.05
Southdown	2.936	1-865	22.95	197.25	366.06
Merino	2.131	1-1191	28.70	113.44	399.81
Cotswold and Leicester	3.370	1-753	34.60	350.98	494.39
Cotswold and Southdown	2.952	1-860	17.20	181.82	333.79
½ Cotswold and ½ Merino	2.336	1-1087	27.05	115.45	339.23
⅞ Leicester and ⅛ Merino	2.329	1-1090	26 10	121.62	281.49
Cotswold and Merino	2.089	1.1215	25.25	103.26	378.57

The tests and measurements thus far given are of wool taken from the animals at the exhibition. The samples of the different grades of wool from Boston, Philadelphia and Germany, were then subjected to as close an analysis, and tests for strength, fineness, uniformity, stretch, elasticity, etc., and the results show a general average with those taken from the animals on exhibition, and also demonstrated how difficult it is to establish a grade upon any given quality.

The commercial wool-grader depends altogether upon the senses of sight and feeling, guided by the demands of the market, and separates the different qualities of wool passing through his hands, rather into the classes demanded, than into those based entirely upon any given quality. In what is known as the "fine wools" or "clothing wools," fineness is of course the prominent characteristic to be considered, while it is intimately connected with strength and elasticity as well. In the "delaine wools," fineness, strength and elasticity must be considered, with proper length of fibre, while the coarse combing wools depend entirely upon length and freedom from impurities with goodly amounts of strength and elasticity, which are desirable in all qualities. If the demands of the market call for more of one grade

than another, the best of a lower or the poorest of a higher will find its way in the grader's hands to the grade most in demand. In no case has an absolute standard been established for each grade.

In the general comparison of the samples from the three markets we find wide variations in the quality of wool in each grade, wider as a rule in those of Boston than in those of the Philadelphia markets, and also a much greater uniformity in the quality of the foreign wools. Too much importance cannot be attached to this, and the facts given should be studied with care by all breeders of fine-wooled sheep or growers of the finer grades of wool, with a view to their practical application, for it explains to a great extent the necessity that impels our manufacturers to send abroad for material to be employed in the manufacture of the finer grades of goods.

It is a lamentable fact that the wools of the United States are wanting in this important quality. This may be due in some measure to the influences to which our animals are naturally subjected by the sudden and rapid changes of our climate, but it is more probable that it may in most cases be traced to the want of that constant care and watchfulness that sheep on the European continent usually receive.

From the conclusions of the Professor, I select the following:

The relative economical value of the different parts of the fleece are as follows, from the greatest to the least, shoulder, side, hip, belly.

Fibres taken from the side closely approximate the average for the whole fleece.

The belly is much the least valuable part.

There is no regularity of increase of stretch and strain with the increase of cross section.

Southdown wool is much stronger than that of any of the other breeds considered. In strength the Merino wool closely approximates the average value of the five breeds. If the Southdown is the strongest and it is adopted as the standard of comparison and its value placed at 100, the relative value of the other breeds is as follows: Oxforddown, 85; Merino, 80.5; Lincoln, 65; Cotswold, 61.

The breeds rank in economical value as follows, from greatest to least: Southdown, Oxforddown, Merino, Lincoln, Cotswold.

A very interesting table showing the relative tenacity and elasticity of wool, as compared with other substances, is given, showing that wool of equal section has twice the strength of the toughest wood, four times that of white pine, five and six-tenths times that of whalebone, and nearly as much as soft brass wire.

If the maximum value of its elasticity be taken as unity, the rela-

tive values of other materials will be as follows: White pine, 4; strongest woods, 5; silk, 3; brass wire, 34; copper wire, 40.

The relatively low value of wool does not affect its actual tensile strength, as it results from the much greater stretch, permitting it to stretch more with a smaller proportional stretch than other materials, thus rendering it much better adapted to the manufacture of clothing.

One hundred and thirty-seven pages of the "Supplemental Report" are given to a thorough comparison of wools from various states—and unfortunately Missouri was not represented—from which twenty deductions are made, the most important of which probably is the sixth, that there seems to be no special relation between the extremes of strain and stretch, and the section in which the wool was grown.

In the concluding forty pages are given tests and measurements of cross-bred wools, the material for which was furnished by Messrs. Baechtel Bros., of Willits, Mendocino county, Cal., who for ten years had been making a series of experiments in crossing pure bred animals, with a view of securing a race of hardy animals, having large size, producing fairly heavy fleeces of wool of good quality and fineness. As this is a subject at present receiving great attention in this section, their conclusions from the results of their experiments are here given:

June 9th, 1884.

DEAR SIR: You desired a statement of our wool-growing experience, which covers a period of nine years.

We commenced by crossing the thoroughbred Merino buck and Southdown ewe, we ran in that direction four crosses; endeavored to ascertain by weighing and averaging our different grades of wool, what progress we were making, which has not given us very satifactory results. We are convinced that seasons have their influence on the growth of vegetation, their variance producing variable wools.

In regard to fineness, length of staple, amount of yolk (which is a very essential element to its perfection; *yolk* is generally considered the pabulum or base of wool), we could only ascertain by weighing each shearing of the different wools shorn and averaging the two shearings to make an annual average.

Our seasons being variable gave us variable results. By referring to our table you will notice our one-half and three-fourths averages. The first year of each made quite a departure from the Southdown family in average weight of fleece. The other two crosses, seven-eighths and fifteen-sixteenths, did not give us such marked results. You will have to take into consideration we were breeding lighter fleeced thoroughbred bucks since 1879. We concluded that year that

our bucks had too much black-top, yellow yolk and grease. We then sought for bucks with long staple, white yolk, and as free from grease as possible, and as free from wrinkles.

In the buck column you will notice a gradual reduction. From that time until in 1882 we fell to 14 pounds average. The next year we bred *grades* as well as thoroughbred buck, an average of 13 pounds; and the present year, ending in the spring, we bred grades and one thoroughbred buck, averaging a little above 14 pounds.

We will give you the whole table.

TABLE NO. 9.

Fall and Spring.	Number of days between fall shearings	Number of sheep shorn.	Annual average of wool per head	Annual average price sold for in Ukiah city.	Net returns per head	Average of Merinos bucks fleeces bred	No. of wethers shorn each year	Southdown, annual average.	1st cross ½ Merino, ½ Southdown, annual average	2d cross ¾ Merino, ¼ Southdown, annual average	3d cross ⅞ Merino, ⅛ Southdown, annual average	4th cross 15-16 Merino, 1-16 Southdown, annual average	⅞ Merino, 1-8 Shropshire, ⅛ Southdown, annual average.	9-16 Merino, 4-16 Shropshire, 3-16 Southdown, annual average	½ Merino, ½ Shropshire, ¼ Southdown, annual average.	Annual per ct. of lambs.
			lbs.					lbs.	lbs.							
1874—1875	367	245	4.60	$0.23½	$1.22	16¾	.....	4.60	.....	.....	.....	.....	.....	.....	.....	60
1875—1876	357	409	5.49	16.2	.78	16.4	20	4.48	7.86	.....	.....	.....	.....	.....	.....	84
1876—1877	366	519	6.19	23.5	1.28	17.4	70	4.49	7.57	.....	.....	.....	.....	.....	.....	97
1877—1878	365	628	7.11	20.0	1.22	17.	112	4.50	7.81	11.22	.....	.....	.....	.....	.....	70
1878—1879	366	514	8.67	21.4	1.73	19 2	168	.....	7.86	10.36	.....	.....	.....	.....	.....	90
1879—1880	366	637	7.99	25.6	1.86	16.5	228	.....	6.61	8.78	11.06	.....	.....	.....	.....	88
1880—1881	373	551	8.74	26.4	2.04	15.	115	.....	6.31	9.12	8.75	.....	.....	.....	.....	75
1881—1882	365	559	8.14	21.1	1.38	14.	53	.....	5.81	8.52	9.44	10.70	.....	.....	.....	55
1882—1883	375	584	8.92	19 1⅜	1.48	13.	.....	.....	6.75	8.88	10.05	10.97	9.14	.....	.....	90
1883—1884	356	711	8.02	17 7/8	1.10	14.	.....	.....	5.12	8.22	.....	.....	8.27	9.44	8.63	80

Our market for wool during that time was Ukiah City, twenty-one miles south of us. A column shows the annual amount sold for. Another, net returns per head after deducting shearings, sacks, sacking, twine, salt, hauling to Ukiah City, all expenses deducted except grass and care You will notice the influence on the price last year, being nearly what the tariff took off, and would be fully so if we had not made a lucky sale this spring. We felt our inability to arrive at correct conclusions by this method, as the fineness of the fibre and its felting properties cannot be determined in that way, or any close distinctions made except by carrying qualities in your eye. The length of staple can be determined.

In 1881 we commenced infusing Shropshire blood in our flock and are gradually working it through. We found the one-half and three-fourths cross between the Merino and Southdown, gave us very satisfactory results. It improved the length of staple of either parent variety, and largely increased weight of fleece. From the Southdown ewe we had large robust sheep. The other two crosses, seven-eighths and fifteen-sixteenths, did not give us much increase of fleece, diminished size, precocity, motherly qualities, and effeminacy. We found we had gone too far in that direction, and last year sold off all the ewes we had above a three-fourth's grade.

In the infusion of Shropshire blood, as far as we have gone, the result has been very satisfactory. It is giving us a large framed and somewhat compact sheep, with quite an increased length of staple and motherly qualities, unsurpassed by the Southdown.

Good milkers—we have considerable to contend with, as most of the flock-masters around us have quite a prejudice against the Down families. They consider they lose the wool on their bellies earlier in life than many other varieties. We rebut it by saying nature never intended a good flock-master to keep sheep beyond their prime. We are gradually wearing out their prejudice by their personal observation, and using some of our grade bucks in their flocks. All we ask is to give them a fair trial. We are satisfied that if the Down families are not run too far into the Merino, they are the most desirable for our locality as large sheep. Our system of rearing and care of sheep is different from older settled States. A large portion of our State is mountainous and adapted to no other class of stock as well as sheep. In fact, large portions of it would be entirely useless if not used for sheep.

Our original stock of sheep were procured from Mexico, and they

were a sorry lot. Early flock-masters in this State tried to improve them, or rather their progeny, by using grade Merino bucks. Their progress was slow as there was no certainty the direction this progeny would take, as there were as many varieties almost as there were sheep, and being bred so long in that haphazard way, many became discouraged and quit the business. With grade bucks, unless they are pretty highly bred, their progress is slow. The improvement of the wool is taken on by degrees, and does not keep pace with the blood crosses, which deceives many persons.

At the commencement of our sheep business we bought all of the standard authors on sheep; read them; applied as many of their suggestions as we could make practicable. Most sheep authors are theorists in a measure. We started with Youatt who, in 1835, made measurement of wool fibre from an English thoroughbred Spanish Merino buck. He measured 750 fibres to the lineal inch. The Germans counted from 40,000 to 48,000 fibres on a square inch of skin from the same class of sheep. Youatt also counted the number of fibres to the lineal inch in the Southdown, making it 660. By calculation we find one-fourteenth of the space of the square inch occupied by the fibre. According to German experiments, by crossing the thoroughbred Merino ram on their coarse sheep, upon which they counted 5,500 fibres to the the square inch by repeated crossings of these two varieties and their progeny on thoroughbred Merino rams, they found the increase of fibres to the square inch was 1,075. Assuming when we commenced our cross-breeds each cross increased the number of fibres 1,075, it would take fifteen crossings to breed up to the Merino standard.

We are located in a favored locality for the production of sheep and wool, unsurpassed by any other in the State, at least so wool buyers say. If we could have furnished weights of carcass with our wool samples, it would have been more satisfactory. Some three-year old three-fourths bucks we sold. At yearlings parties took the pains to weigh them; they weighed from 168 to 198 after they were shorn, and their spring fleeces of eight months' growth gave us an average of nine pounds.

We expect much from our lambs of last February as wool yielders. They are one-half Shropshire and one-half Merino—the sire Shropshire, the ewe Merino. We propose to cross them with a thoroughbred Merino buck, which will give us three-fourths Merino and one-fourth Shropshire.

For further particulars in regard to this effort to develop an all-purpose sheep the whole correspondence must be read, and it will be

found to be both interesting and instructive, and in connection with Prof. McMurtrie's tests and measurements of their cross-bred wool, will furnish information for those who are working for the same end.

The general averages are as follows:

TABLE NO. 10.

Breeding.	Fineness.		Stretch in per cent of length.	Strain in grains.	
	In centimillimeters...	In fractions of an inch.		Average natural diameter.....	Reduced to same diameter of $\frac{1}{1000}$ of an inch.
$\frac{15}{16}$ Merino, $\frac{1}{16}$ Southdown.....	1.965	1-1292	33.50	86.66	354.92
$\frac{7}{8}$ Merino, $\frac{1}{8}$ Southdown	1.929	1-1316	28.90	91.61	405.34
$\frac{3}{4}$ Merino, $\frac{1}{4}$ Southdown	1.923	1-1320	40.43	78.53	339.72
$\frac{1}{2}$ Merino, $\frac{1}{2}$ Southdown	2.394	1-1060	40.96	117.47	327.85
$\frac{1}{4}$ Shropshire. $\frac{9}{16}$ Merino, $\frac{3}{16}$ Southdown	2.122	1-1196	37.92	87.98	312.56
$\frac{1}{2}$ Shropshire, $\frac{3}{8}$ Merino, $\frac{1}{8}$ Southdown	2.437	1-1042	34.64	130.59	351.71
$\frac{1}{2}$ Shropshire, $\frac{1}{4}$ Merino, $\frac{1}{4}$ Southdown	2.358	1-1077	38.30	113.44	326.39

The variations are great. In fineness, from 1-2539 inch to 1-508 inch. An apparent variation in the diameter of the same fibre of from 15 to 20 per cent.

An exceptionally high extreme of stretch, reaching 85 per cent., the length tested, while the minimum falls as low as 10 per cent. and even 5 per cent. of the length tested.

In the averages for fineness for the several classes there is less variation than might be expected. Until the Merino blood falls below one-half there is no discernable influence of the cross upon the fineness. With an increase of Shropshire blood there is a regular increase in the diameter of the fibre. For the production of medium wools the grade animals here described will yield as good a product as animals of pure blood.

So hasty a culling as this has necessarily been, must result in the omission of much of importance and more of very great interest. The work is commended to sheep-breeders and wool-growers; they will find facts and suggestions in it which cannot but be of value to them in their endeavor to produce the most mutton and the largest fleece of good wool for the least money.

WOMAN ON THE FARM.

BY MRS. G. E. DUGAN, SEDALIA, MO.

Having been invited to present individual views on the above theme, I shall do so conscientiously and according to the light of my best understanding.

Woman on the farm, as in all other spheres, is quite necessary for advancement and prosperity. The weight of the universe seems to rest on her slender shoulders, and old Atlas appears to have shirked from his original duty, leaving her to stagger on as best she may under this great weight, or to sink beneath its responsibilities; even as Adam, coward-like, laid all the blame of the mischief done in Eden on his gentle spouse. It has been frequently said—and by those of his own sex—that "man is proverbially selfish," and while spending any amount of money to lighten his own labor, gives grudgingly the mite which should be accorded unasked to make easier the work of the household.

My experience in farm life was in one of the Middle States, and there, at least, was no need for complaint. The farmer's wife had her sewing machine, her washing machine, the latest improved churn, and whatever else would best aid her to perform her tasks easily. Besides, she never did any out-door work, such as carrying wood, water and milking cows, these "chores" were relegated to the sterner sex, except, perhaps, in harvest time, or in the rush of "threshing machine" experiences.

Missouri is practically a pioneer State, notwithstanding the fact that her first American settlement dates back almost a century, and that she has such a grand area of tillable and beautifully diversified farming land, and other resources of the greatest magnitude. It is not necessary in this paper to discuss the "whys and wherefores" of

this fact, let it stand simply as a fact, and from its standpoint discuss woman on the Missouri farm.

Pioneer life is the bravest, the noblest and the hardest kind of life. Beginners on the farm are subjected to trials, inconveniences and hardships literally unknown to beginners in any other sphere of action. Labor is harder, and results more tardy, than the unthinking have any conception of, and the pinching economies of such a commencement will leave dwarfing marks on the minds of every person who does not see the danger and guard well against it.

Granted that you have economized and toiled until the iron yoke of poverty is lifted from your neck and you feel yourself to be once more a free man. Now is the time to set your foot upon pettiness and to show your noble self-sacrificing wife how much you appreciate her brave spirit. Make her burdens as light as possible and spend your money freely in the home. No investment that you can possibly make will pay you so well, and nothing you ever did, or ever will do, can bring you such a yield of happiness.

From bright, cheerful, happy homes, children seldom go to destruction, therefore let the necessary books be purchased and periodicals be subscribed to, that will feed the mind and satisfy the youthful craving for knowledge, which is just as natural and strong as the stomach's desire for bread.

Provide brain food for your family, and then watch them grow in mental grace and beauty day by day, and you will feel amply repaid for the outlay.

Every woman who does her own sewing should have a sewing-machine, not an old broken down, second-hand affair, but the best and lightest running machine the market affords.

Then she should, by all means, have a good steam washer and a wringer, and one of those justly celebrated "Bentwood churns" the the only real labor-saving and superlatively excellent churn I have ever seen, though there may be others quite as good which have not come beneath my observation. Women themselves are often to blame for degenerating into mere drudges.

As a rule, I believe that women are a trifle "stingier" than men know how to be.

A little money seems to them such a vast amount, sometimes, (because they have had such slim purses always) that they think to spend it would be shameless extravagance, even when it is given to them freely, to buy some needed improvement to save their own health and strength.

Let me advise you my dear sisters on the farm! Get what you *need* and *rest* when you are *weary*, even though you wear nothing but five cent calico all your lives, and John's supper waits when he is in an "awful hurry" to get down to the corner grocery or out there by the old school house where the boys and idle men are pitching quoits, and surreptitiously passing a suspicious looking bottle which is not filled with cold tea, even if they do declare it to be "young hyson."

Sons like to be proud of their mothers, and husbands doubly respect and venerate wives who are refined and educated, therefore, do not sink from the level of a loved companion to the position of a semi-despised slave. Take time to read, not now and then, a little while on Sunday afternoon, but *every day* or evening of your life.

Don't let me catch you with a huge basket of mending by your side on a winter evening, unless your husband or one of the children intends to read some good newspaper or book aloud for your benefit.

If your husband does not like to read aloud and the children are too young to favor you, it is your duty to employ at least *one* hour of each evening in reading aloud to them, even if they are obliged to wear ragged clothes in consequence.

The soul is of much more consequence than the body, and scientists locate the temporal home of the soul in the intelligence, or brain cells.

If you have no books and are not able yet to buy any, borrow from your neighbors, but do not soil, tear or "dog-ear" a borrowed volume of any sort. Put a paper cover on it, keep it out of the way of children too small to read or understand it, and just as soon as you have finished its perusal, *send it home.*

All this may sound dictatorial and impudent, but if you could only understand how deeply I have your welfare at heart, you would not take offense at the minutia which may seem irrelevant, but which is too often neglected in papers designed to do good. Marriage is a co-partnership where one has the same right to the common purse as the other. No married man can thrive without the consent of his chosen companion, yet women do not receive one-half the credit due to them for the good management which brings affluence and respectability to the family.

Dear reader, you can recall to your mind some family held together and kept respectable by the thrift, economy and persevering industry of a good woman, unequally yoked to a miserable, thriftless, idle and good-for-nothing man, but have you, in all the years of your experience, ever known a man to do well and a family to be respectable with a slatternly, slipshod, "no-account" woman at the head of the home?

You may answer at your leisure, and if you can bring forward one such instance, please notify me, as I should be glad to know if there be such a case in existence.

When mothers are degraded to the level of beasts of burden, the children are sure to be common and coarse. The mother's mind is the formative one, and children receive their earliest and most lasting impressions from her instruction, therefore it is a great mistake and an absolute retrograding toward barbarism when women are looked upon as fit only to toil as does the horse or ox.

I believe that men, as a rule, intend to be kind, generous and appreciative, but women who are accustomed to overworking, spoil their husbands and also spoil their sons, which is not only unfortunate so far as the women are concerned individually, but also bad for the future of their sons' wives.

I personally know a mother who is far from being strong, yet she has so systematically spoiled her only son, that he is looked upon with contempt by his neighbors and despised where he might have been respected had he received proper training. He will sit by the fireside and allow his mother to bring in heavy buckets of coal, and on the coldest days he will not milk a cow, and she has all of the outdoor and indoor work to do, although he is man grown and healthy. To compensate his mother for her hard labor, he cheers her up by "strumming" on an old guitar or banjo most of the time. It is a spectacle to make the gods weep, and yet one cannot feel a vast amount of pity for so foolish a woman.

There is a great deal of quiet romance, and real love, and genuine tenderness in the homes of many farmers, and there is a lamentable "other side" to the picture, so bleak, so chilling, so utterly desolate, that we turn from its contemplation in absolute despair.

What does it signify though the sentient blossoms generously shed their heart's richness on the tender atmosphere, if the senses are too dulled by care and toil to note their sweet offering?

Or what signifies the rapturous warblings of the happy birds, to souls so full of trouble that they neither see nor hear them?

The green blades of the spring grass come forth smiling, and the heavy foot that crushes them down might as well tramp over cheerless pavements for all the beauty its owner can see in the luxuriant carpet of verdure.

The leaves whisper, sigh and rustle with joy and thankfulness, and man goes out to feed his herds and has no eye for the beautiful pictures they make and is scarcely grateful for the refreshing shade. These things ought not so to be.

The truly æsthetic man and woman ought to find their purest enjoyment in the country.

We build for ourselves monuments of pain and care; we rear them as carefully as the ancients did the pyramids, and when we get them high enough they topple over and crush us into nothingness beneath their grinding surfaces. We do not know why we do this, and we often think we will stop it, but having once begun to rear these awful things we work at them by a strange facinating fatality until they are great enough to finish our earthly career.

There is a world of quiet philosophy in that question asked by Jesus of Nazareth, the savior of mankind, and I wonder that more persons do not pause to ponder the pertinent inquiry: "What shall it profit a man if he gain the whole world and lose his own soul?"

BULLETIN No. 28.

MAINTENANCE RATIONS FOR PIGS.

BY J. W. SANBORN, DEAN.

MISSOURI AGRICULTURAL COLLEGE FARM,
COLUMBIA, MO., June 4, 1887.

S. S. LAWS, LL. D., *President University of Missouri and Agricultural College:*

SIR—The statistics of the National Department of Agriculture give the number of hogs for Missouri as 3,876,325, this being, in common with other States, quite a reduction from the previous year, when over 4,000,000 were recorded. But one State, Iowa, keeps as many swine as does our State. Any statistics, therefore, that bear upon the growth of swine are of special value to our farmers, whose investment is over $14,000,000 in these animals, and whose annual sales are very nearly their estimated value in February, or $14,000,000.

Believing that the knowledge of what constitutes the maintenance ration of swine will throw valuable light upon the economy of their growth, I have made some direct tests of the question and have other facts that will aid us in arriving at approximate data.

The following table is the result of an experiment to determine what maintenance ration is:

FEEDING FOR MAINTENANCE.

PERIOD I.—TABLE I. FOOD, MIDDLINGS.

No. fed.....	Lots.....	Weight, lbs.	Grain, lbs..	Ate.....	Days fed...	Per ct. eaten daily...	Gain per day each..	Food eaten for lb. gain.
3	1	482	36	275	16	3.57	.75	7.64
3	2	513	66	275	16	3.35	1.39	4.16
3	3	478	47	255	16	3.05	.98	5.42
3	4	528	68	305	16	3.59	1.41	4.48
12	Average	500 each 166.6	54.2		16	3.39	1.13	5.42

The above rations per day, although limited to less than the shotes would eat, proved fair growing ones. The shotes ate and then remained at almost perfect rest between meals. The next period less was fed:

PERIOD II.—TABLE I *b*.

No. fed....	Lots.....	Weight, lbs.	Gain, lbs'..	Ate.....	Days fed...	Per ct. eaten daily...	Gain per day each..	Food eaten for lb gain.
3	1	502	4	277½	28	1.97	.047	69.
3	2	503	5	283	28	2.00	.059	56.6
3	3	540	loss 6	303	28	1.96	loss	.....
3	4	560	0	320	28	2.04	.000	.....
12	Average	521 each 173.6	3		28	1.99	.0008	

Four lots of shotes whose food slightly varies in amount agree as closely as the varying capacities of animals can be expected to, and show for animals weighing 173 pounds that 2 per cent. of live weight daily is a safe maintenance ration for July.

PERIOD III.—TABLE 1 c.

No. fed....	Lots.....	Weight, lbs.	Gain, lbs...	Ate...	Days fed...	Per ct. eaten daily...	Gain per day each...	Food eaten for lb gain.
3	1	517	26	116	7	3.18	1.23	4.46
3	2	561	20	100	7	2.77	.95	5 00
3	3	544	8	90	7	2.84	.38	11.25
3	4	565	10	72	7	1.82	.47	7.20
12	Average	535.5 each 178.5	16		7	2.52	.75	6.98

A slight increase over maintenace ration was given in this period, varying with each lot to note results. The more the increase the better, and the more economical the growth. This is again seen when comparing the growth of period I. with its still greater excess of food with period III.

In perion III. .53 per cent. weight of the shotes is given above what is found to be maintenace ration in perion II., or .94 pounds middlings daily. For this excess, .94 pounds above maintenance food, we get a growth of three-fourths of a pound, or seemingly 1.26 pounds of middlings have made a pound of growth. This trial was largely made to illustrate the folly of our unpardonable and indefensible practice of keeping hogs 15 to 18 months to obtain the growth that may well be made in seven to eight months. The growth made in the first period would give a shote weighing in seven moths 240 pounds, including his birth weight. This would be got from the feeding, on a basis of 2 per cent. for maintenance, of only 349 pounds more food than necessary to maintain existence.

Now, if a shote is kept fourteen months, or twice seven months, the maintenance food, at 2 per cent. daily, would be 504 pounds for the extra seven months uselessly feed, or, in other words, maintenace rations are greater than the food of growth; and those of us, which is about all of us, who feed fourteen months, actually throw away more food in unnecessary maintenance than the actual food of growth by 44.4 per cent.—144.4, the amount actually needed. Regarding this food as middlings, at $14 a ton, we have a value of $3.52 thus lost in maintenance, or for the 3,876,325 hogs of our State, $13,644,640.

As now managed, I believe our swine are our most unprofitable stock. But the per cent. eaten varies with age, as very full figures given in a later table will show. To test this upon maintenance for pigs, a lot was fed at the same time the shotes were fed. Before giving the table, I should state that the weights given for the shotes in above trials are the average of each period, and not the weight at the close of it. This explains the apparent discrepancy between weight and gain columns.

MAINTENANCE FOR PIGS.

PERIOD I.—TABLE NO. 2.

Lots.....	Number fed	Weight....	Gain.....	Ate.....	Days fed...	Per cent. eaten daily	Gain per day per pig	Food eaten per pound gain.....
1	3	143½	11½	42	7	4.18	.88	3.65

PERIOD II.

1	3	145	1½	63	21	2.07	.026	42.00

Maintenance rations for these 50 pound pigs was less than I expected to find it, although more than for the shotes. A less number of them were involved than the heavier shotes, and as the maintenance standard varies with the individual and with conditions, I deem the result less satisfactory, yet approximately correct to a true law.

WINTER TRIAL.

It was thought to be desirable to test the influence of temperature on maintenance ration. For this purpose three shotes were put up in February. Unfortunately February persisted in being a very warm month. I will give the winter temperature during both trials after giving the winter trial.

PERIOD I.—TABLE NO. 3.

Lots.....	Number fed	Weight....	Gain.....	Ate.....	Days fed...	Per cent. eaten daily	Gain per day per pig	Food eaten per pound gain.....
1	3	497	45	176	15	236	1.00	3.91
2	3	482	35	154	15	217	.77	4.48

PERIOD II.—TABLE 3a.

1	3	521	2	168	18	1.78	.037	84.00
2	3	509	18	184	18	2.00	.33	10 40

PERIOD III.—TABLE 3b.

1	3	523	2	90	10	1.72	.06	45.00
2	3	518	1	82	10	1.58	.63	82.00

The summer temperature during the first trial was that of the last of May, all of June, (June 73.8°) and early July, (July averaged 80°). I was not then keeping the temperature, so the above is for other points in the State. But I deemed it too hot, as summer temperature is too hot for the best results. The temperature of February was 36.4°, and of March, during which time the trials were progressing, 47.5°.

Period two shows that 1.89 per cent. of food is a little more than is necessary for maintenance. During period three in March, on a moderate temperature, in small pens, with little exercise, 1.65 per cent. of live weight on hogs weighing 173 pounds each, was enough for existence. This was for shotes above their average weight, from birth to slaughter, and on the minimum of exercise and for favorable temperature. For shotes weighing 120 pounds, at about which weight the average stands from birth to slaughter, for all temperatures and conditions and for good middlings as food, from 1.80 to 2 per cent. of live weight, or 2.2 or 2.4 pounds food daily will be required for maintenance rations. Under our average condition, as found in the State, with roaming, shelterless pigs using whole corn, more than 2 per cent. will be used.

As bearing upon this question, I have tabulated in all about 110 feeding periods with swine, which I have carried on for the last ten years, with various foods.

In making the tables I have found it would be of probable interest to the public to arrange a table showing the influence of foods. In these tables I have embodied all of my trials that would work in, that is, no results have been omitted in the interest of any food or view that I may have held. Some five trials out of over one hundred have been omitted because too abnormal to be used, and these were distributed evenly among the foods and were not due to the kind of food fed.

Table No. 4 groups all pigs whose weights were under 50 lbs., and considers their relation to amount eaten and the economy of feeding at the age involved. Table No. 5 considers shotes from 50 to 100 lbs., and so on for each table by rises of 50 lbs. in weight of swine above preceding table.

The weights of the swine fed are in all cases taken at the middle of the feeding trial, hence they are always smaller than the table shows, at the beginning of the trial. Again, if the period of feeding seems short to some, it may be said that each period is but part of a long feeding period, that covers often five months or more, but usually with a change of food at some intermediate period.

TABLE NO. 4.

GROWTH BY WEIGHT—LOTS WEIGHING UNDER FIFTY POUNDS.

No. of animals fed..	Weight of lot	Whole gain.	Am't eaten	Days fed for one hog...	Days each lot were fed..	Per cent. live wt. eaten daily.....	Gain per day	Pounds food for pound gain.....	
3	143	11.5	42	21	7	4 18	.54	3.65	
2	90	32	131.5	56	28	5.02	.57	4.70	
2	56	31	100	62	31	5.80	.50	3.23	
2	93	45	180	72	36	5.30	.62	4.00	
2	79	56	235	108	54	5.60	.52	4.90	
2	96	48	174	56	28	6.50	.85	3.60	
2	61	41	134	62	31	7.08	.66	3.06	
8	196	93	370	112	14	12.50	.78	4.00	
2	84	5	95.7	56	28	4.00	.80	2.13	
2	100	50	185	88	44	4.20	.57	3.70	
2	37	17	83	62	31	7.25	.27	4.80	
2	53	14	90	72	36	4.70	.19	6.40	
2	71	38	124	62	31	4.00	.60	3.26	
2	60	25	116	62	31	3.70	.41	3.90	
2	61.4	27	185	108	54	5.48	.25	6.89	
2	46	131	379	100	50	7.90	1.31	2.90	
2	98	135	398	100	50	8.10	1.35	2.90	
2	89	118	308	100	50	6.90	1.18	2.60	
2	96	48	174	56	28	4.00	.80	2.12	
2	76.7	64.5	184	62	31	7.75	1.20	2.85	
47	1652.1	1025	3593.2	1421	665	115.96	13.16	73.49	
20	35.1	21.9	76.45	30.23	33.25	5.79	.66	3.67	Averages

TABLE NO. 5.

GROWTH BY WEIGHT—LOTS WEIGHING 50 TO 100 POUNDS.

No. of animals	Weight of lot	Whole gain.	Am't eaten.	Days fed for one hog...	Days each lot were fed..	Per cent. live wt. eaten daily.....	Gain per day	Pounds food for pound gain.....	
3	151	91	334	138	46	4.85	.646	3.67	
3	152	13.5	26	21	7	2.43	.643	1.91	
2	135	58	215	78	39	4.61	.743	3.01	
2	192	56	290	86	43	3.51	.651	5.18	
2	160	90	380	84	42	5.65	1.071	4.22	
2	157	75	250	84	42	3.79	.893	3.33	
2	156	62	281	104	52	3.47	.596	4.53	
2	151	89	215.5	78	39	3.62	1.140	2.42	
2	147	90	259	72	36	4.88	1.250	2.87	
2	110	40	193	72	36	4.87	.555	4.82	
2	167	75	269	84	42	3.83	.893	3.58	
2	178	112	438	106	53	4.64	1.057	3.73	
2	183	108	396	106	53	4.08	1.017	3.67	
2	182	106	417	106	53	4.31	1.000	3.93	
2	184	63	388	106	53	3.98	.877	4.17	
2	103	145	365	100	50	7.08	1.460	2 50	
3	151	79	397	135	45	5 84	584	5.03	
2	138	93	272	88	44	4 48	.716	4.31	
2	177	117	390	78	39	5.66	1.500	3.33	
2	101	38	210	72	36	5.88	.522	5.25	
43	3075	1060.5	5985.5	1798	850	91.46	17.82	75 96	
20	71.5	37.2	139	41.8	42.5	4.57	.89	3.79	Averages

TABLE NO. 6.

GROWTH BY WEIGHT.—LOTS WEIGHING 100 TO 150 LBS.

No. of animals.	Weight in lbs.	Whole gain	Amount eaten.	Days for one hog fed	Days each lot were fed	Per cent. eaten to live weight daily	Gain per hog per day	Pounds food for pounds gain.	
4	430	188	808	252	63	3.000	.746	4.30	
2	247	55	187	52	26	2.91	1.059	3.40	
2	227	55	168	28	14	5.28	1.964	3.05	
2	296	162	674	108	54	4.22	1.500	4.16	
4	498	84	552	208	52	2.13	.403	6.57	
2	249	56	339.7	86	43	3.17	1.232	3.20	
2	287	106	416	104	52	2.78	1.019	2.92	
2	250	110	400	84	42	3.81	1.309	3.63	
2	282	93	389	74	37	3.72	1.256	4.18	
2	282	35	178	60	30	2.10	.583	5.08	
2	235	105	355	74	37	4.04	1.419	3.38	
2	233	79	323	64	32	4.20	1.234	4.09	
2	236	78	321	64	32	4.24	1.218	4.11	
2	257	100	340	64	32	4.13	1.562	3.40	
2	225	87	286	64	32	3.97	1.359	3.29	
4	491	134	762	208	52	2 98	.644	5.69	
2	202	65	360	104	52	3.42	.625	5.54	
2	228	47	200	28	14	6.27	1.679	4 25	
2	267	100	427	86	43	3.72	1.163	4.27	
4	590	188	594	156	39	2.58	1.205	3.16	
48	6,240	1,966	8,579	1,998	793	79.03	24.45	87.84	
20	124.8	39.3	171.6	39.9	37.7	3.76	1.16	4.18	Averages.

TABLE NO. 7.

GROWTH OF WEIGHT.—LOTS WEIGHING 150 TO 200 LBS.

No. of animals.	Weight of lot.	Gain	Amount eaten.	Days for one hog	Days for whole lot	Per cent. eaten to live weight daily	Grain per day.	Pounds food for pound grain.	
3	513	66	275	48	16	3.55	1.375	4.166	
3	474	47	255	48	16	3.34	.979	5.425	
3	528	68	305	48	16	3.61	1.417	4.485	
2	326	90	242	60	30	2.47	1.500	2.690	
4	742	184	1,185	124	31	5.16	1.484	6.440	
4	760	320	1,207	124	31	5.13	2.580	3.771	
2	375	70	385	106	53	1.94	.660	5.500	
2	358	46	230	52	26	2.47	.884	5.000	
2	325	40	164	28	14	3.60	1.429	4.100	
2	362	85	300	60	30	2.76	1.417	3.571	
4	775	268	1,253	124	31	5.21	2.160	5.052	
2	347	60	289	52	26	3.23	1.154	4.817	
2	352	85	300	60	30	2.83	1.417	3.529	
2	372	133	470	98	49	2.57	1.357	3.534	
2	325	115	489	98	49	3.07	1.173	4.252	
2	321	98	425	98	49	2.70	1.000	4.337	
41	7,259	1775	7,961.5	1,224	397	53.44	21.80	70.66	Average
16	177	43.29	194.1	29.85	24.9	3.34	1.36	4.37	

TABLE NO. 8.

GROWTH OF WEIGHT.—LOTS WEIGHING 200 TO 250 LBS.

No. of animals.	Weight of lot.	Gain	Amount eaten.	Days for 1 hog.	Days each lot were fed	Per cent. eaten to live weight daily	Gain per day.	Pounds food for pound gain.
4	924	180	1,140	120	30	4.11	1.500	6.333
2	434	115	590	88	44	3.09	1.304	5.130
2	434	107	342	60	30	2.61	1.783	3.200
2	414	75	285	60	30	2.29	1.250	3.800
2	412	80	347	58	29	2.90	1.355	4.337
2	477	75	318	58	29	2.30	1.293	4.240
2	440	90	389	58	29	3.04	1.552	4.322
16	3,535	722	3,411	502	221	20.34	10.039	31.362
7	221	45.1	213.2	31.4	31.5	2.905	1.434	4.480

TABLE NO. 9.

GROWTH BY WEIGHT.—LOTS WEIGHING 250 TO 300 LBS.

No. of animals.	Weight of lot..	Gain.....	Amount eaten.	Days for 1 hog.	Days each lot were fed.....	Per cent. eaten to live weight daily.....	Gaan per day..	Pounds food for pound gain..
4	1,009	178	1,123	120	30	3.71	1.483	6.365
4	1,060	92	568	68	17	3.15	1.353	6.174
4	1,146	96	534	68	17	2.74	1.412	5.560
4	1,031	235	1,329	120	30	4.29	2.040	5.425
2	558	133	660	104	52	2.28	1.278	5.000
18	4,804	744	4,214	480	146	16.17	7.566	28.524
5	267	41.3	234	26.6	28.4	3.23	1.513	5.704

TABLE NO. 10.

GROWTH BY WEIGHT.—LOTS WEIGHING 300 TO 350 LBS.

No. of animals.	Weight of lot..	Gain.....	Amount eaten..	Days for 1 hog.	Days each lot were fed.....	Per cent. eaten to live weight daily.....	Gain per day...	Pounds food for pound gain...
2	662	75	644	106	53	1.83	.707	8.59
4	1,293	125	614	68	17	2.79	1.838	4.91
6	1,955	200	1,258	174	70	4.62	2.545	13.40
3	326	33.3	209	29	35	2.31	1.272	6.75

TABLE NO. 11. MIDDLINGS.

GROUPS ACCORDING TO FOODS FED.

No. of animals	Weight of lot	Gain	Amount eaten	Days for one hog	Days for whole lot	Per cent. eaten to live weight	Gain per day	Pounds food for pound gain	
4	430	188	808	252	63	3.00	.75	4.30	
3	151	91	334	138	46	4.85	.646	3.97	
3	513	66	275	48	16	3.35	1.37	4.16	
3	478	47	255	48	16	3.34	.98	5.42	
3	528	68	305	48	16	3.61	1.42	4.48	
3	143	11.5	42	21	7	4.18	.54	3.65	
3	152	13.5	26	21	7	2.43	.64	1.91	
2	90	32	131.5	56	28	5.02	.57	4.70	
2	135	58	215	78	39	4.61	.74	3.01	
2	192	56	290	86	43	3.51	.65	5.18	
2	247	55	187	52	26	2.91	1.06	3.40	
2	326	90	242	60	30	2.47	1.50	2.68	
2	56	31	100	62	31	5.80	.50	3.23	
2	93	45	180	72	36	5 30	.62	4.00	
2	160	90	380	84	42	5.65	1.07	4.22	
2	157	75	250	84	42	3.79	.89	3.33	
2	227	55	168	28	14	5.28	1.96	3.05	
42	4,078	1,072	4,388	1,238	502	66.63	14.40	62.01	Total.
17	97.09	25.5	104.2	29.4	29.5	3 92	.847	3.65	Average.

These tables are very important. They show that the per cent. eaten steadily declines with increasing size, and as steadily requires an ascending amount of food for a pound of growth. As they approach maturity this growth cost rapidly advances in a new ratio. Fifteen years of work with and for farmers at Institute meetings, and by correspondence, have shown me that the belief is almost universal that the advanced shote, say weighing 150 pounds and upwards to 200 pounds, will make growth cheaper than shotes weighing 150 pounds and downward. This false view is tenaciously held, despite evidence to the contrary.

These tables ought to be conclusive on this point, and, when added to the maintenance facts given, ought to banish almost every shote over 8 or 9 months from our State. The 350 pound hog requires nearly twice as much food for a pound of gain as does the 50-pound pig, by the preceding tables.

Little pigs eat 7 per cent. of live weight daily and over, even up to 12 1-2, for very little things. From this height it dwindles until a little over 2 per cent. gives good gain on hogs of over 300 pounds weight. The reason is obvious. Maintenance must be greater for the radiating surface of a small pig with all of the organs to run that a

large one has. Again, the chief reason rests in the fact that 1 per cent. of a small weight is small. Thus, if it requires 1 1-2 pounds of excess food above maintenance rations to make a growth of a pound, it will require 5 per cent. of a 30-pound pig to give it. This, added to 2 per cent. for maintenance, gives 7 per cent.

Critical observers will notice that the table in detail shows noticeable variations from the average of all the trials of the tables. I wish it distinctly understood that these trials were for experimental purposes with other objects in view, and hence represent various foods and various seasons of the year. These conditions, as a whole, are almost or quite balanced between the various periods, and hence the uniformity of the footings and of the truths shown.

COST OF GROWTH.

The tables represent a most valuable economic truth. We hear much said about ten pounds of pork for a bushel of corn being a standard for good farmers to reach. The average growth from the little pig to 250 pounds, as large a weight as we should aim for, by these tables is 1 lb. for 4.33 lbs. of food on 4.18 per cent. of live weight eaten daily. If we stop feeding at 200 pounds, or the spring pig sold in the fall, the true way, only 3.99 pounds of food are required for one pound of growth, or for 56 pounds of food, 14 pounds of growth is gained.

But it must be remembered that this is the average of nearly one hundred weighing periods, on all sorts of food, tried not for rapid growth, but for tests of one food against another, to ascertain their relative value. In these foods are found bran, cotton-seed meal, clear cob meal, etc. In short, a skillful farmer ought to easily do as well or better than the tests reveal. Yet the farmers fall far below 14 pounds growth of hogs for 56 pounds of food. I am sure that I can do better in farm practice than I did by these trials.

RELATIVE VALUE OF FOODS.

The following tables group the foods given by themselves, and are in sufficient amount to give an approximation of their relative value for swine:

TABLE 12.

CORN MEAL.

Hogs.	Weight.	Gain, Pounds.	Ate, Pounds.	Days.	Per cent.	Gain per day.	Food for pound gain.
4	491	134	762	52	2.98	.64	5.7
4	775	268	1,253	31	5.2	2.16	5.5
4	1031	245	1,329	30	4.3	2.0	5.5
4	1293	125	614	17	2.8	1.7	4.9
3	151	79	397	45	5.8	.58	5.02
2	79	56	235	54	5.6	.52	4.9
2	138	63	272	44	4.4	.71	4.3
2	558	133	660	52	2.2	1.27	5.0
2	202	65.4	360	52	3.4	.63	5.5
2	96	48	174	28	6.5	.85	3.6
2	177	117	390	39	5.6	1.5	3.3
2	267	100	427	43	3.7	1.16	4.2
2	347	60	289	26	3.2	1.15	4.8
2	414	75	285	30	2.3	1.25	3.8
2	228	47	200	14	6.0	1.68	4.25
4	596	188	594	39	2.5	1.20	3.0
2	228	47	200	14	6.27	1.68	4.2
2	61	41	134	31	7.8	.66	3.6
2	101	38	210	36	5.88	.52	5.25
2	321	98	425	49	2.7	1.00	4.3
2	412	80	349	29	2.9	1.35	4.3
2	477	75	318	29	2.3	1.29	4.2
2	440	90	389	29	3.0	1.55	4.3
2	352	85	300	30	2.8	1.42	3.5
59	9,229	2,358	10,566	843	100.13	27.47	111.47
24	156.4	39.6	179.0	35.1	4.16	1.14	4.64 Ave'gs

I have found middlings, in trial on hogs of like weights, side by side, to be better than cornmeal. But in this table it will be seen that the hogs average to weigh 59.4 lbs., more than in the shipstuff-fed lots. By the first tables it was seen that the less the weight of the pigs, the less food required for a pound of gain. This difference is .39 of a pound against cornmeal. But, on the other hand, the smaller the pig the more he eats. In the above trials the middlings-fed pigs ate only 3.92 per cent. of live-weight daily, while the corn-fed lots ate 4.16 per cent. of their greater weight, which more than counterbalances the .39 lbs. against corn meal on account of greater weight of hogs. Everything in my experience favors middlings against corn meal up to fattening. The use of corn meal for fattening, and middlings for young pigs, accounts for the above difference in weight of hogs.

TABLE NO. 13.

Bran and Meal.

No of animals.....	Weight of lot.....	Gain.....	Amount eaten.....	Days fed for 1 hog.	Days each lot were fed.....	Per cent. live wt. eaten daily.....	Gain per day.....	Pounds food for pound gain.....	Remarks.
2	287	106	416	104	52	2.79	1.019	3.924	
2	375	70	385	106	53	1.937	.688	5.50	
2	358	46	230	52	26	2.471	.886	5.00	
6	1,020	222	1031	262	131	7.198	2.593	14.424	
3	170	37	171.8	43.6	43.6	2.399	.864	4.808	Average.

TABLE NO. 14.

Milk and Sundry Meals.

No. of animals.....	Weight of lot.....	Gain.....	Amount eaten.....	Days fed for 1 hog.	Days each lot were fed.....	Per cent. live wt. eaten daily.....	Gain per day.....	Pounds food for pound gain.....	Remarks.
2	76.7	65.5	184	62	31	7.80	1 20	2.80	Corn meal and milk.
2	157	90.0	259	72	36	4.60	1.27	2.80	Corn meal and milk.
2	96	131.0	379	100	50	7.90	1.31	2.90	Cob meal and milk.
2	98	135	398	100	50	8.10	1.35	2.90	Meal and milk.
2	233	79	323	64	32	4.30	1.23	4.00	Meal and milk.
2	89	118	308	100	50	6.90	1.18	2.60	Milk, corn meal and middlings
2	103	145	365	100	50	7 00	1.45	2.50	Milk and middlings.
2	236	78	321	64	32	4.20	1.15	4.10	Cob meal and milk.
16	1078.7	841.5	2,537	662	331	50.80	10 14	24.60	The skim milk and meal combination is without a peer,
8	67.42	52 6	158.56	41.37	41.37	6.36	1.27	3.07	especially for young pigs.

TABLE NO. 15.

ABOUT FOUR-FIFTHS CLEAR COB MEAL AND OTHER MEALS ADDED.

No. of animals.....	Weight of lot.....	Gain.....	Amount eaten.....	Days fed for one hog	Days each lot were fed.....	Per cent. live weight eaten daily.....	Gain per day.....	Pounds food for pound gain.....	Remarks.
2	178	112	438	106	53	4.6	1.06	3.7	Cob and cotton seed meal.
2	183	108	396	106	53	4.0	1.04	3.6	Cob and cotton seed meal.
2	182	106	417	106	53	4.3	1.00	3.9	Cob and bran meal.
2	282	93	389	74	37	3 7	1.25	4.18	Cob and cotton seed meal.
8	825	519	1640	392	196	16.6	4.35	15.38	
4	103.1	64.9	205	49	49	4.15	1.09	3.84	Average.

TABLE NO. 16.

CORN MEAL AND MIDDLINGS.

No. of animals.....	Weight of lot.....	Gain.....	Amount eaten.....	Days fed for one hog	Days each lot were fed.....	Per cent. live weight eaten daily.....	Gain per day.....	Pounds food for pound gain.....	Remarks.
2	37	17	83	62	31	7.3	.27	4.8	
2	71	38	124	62	31	4.0	.60	3.26	
2	257	100	340	64	32	4.1	1.56	3.4	
2	225	87	286	64	32	4.0	1.36	3.3	
2	372	133	470	98	49	2.6	1.35	3.5	
2	352	85	300	60	30	2.7	1.41	3.5	
2	110	40	164	72	36	4.8	.55	4.82	
14	1424	500	1,767	482	241	29.5	7.10	26.58	
7	1,01.7	36.7	126.2	34.4	34.4	4.2	1.01	3 79	Average.

TABLE NO. 17 —WHOLE CORN.

GROUPING VARIOUS FOOD.—LOT III.

No. of animals.....	Weight of lot.....	Gain.....	Amount eaten.....	Days for one hog ...	Days for whole lot..	Per cent. eaten to live weight daily.	Gain per day.....	Pounds of food to pound of gain.....	Remarks.
4	384	80	687	252	63	2.84	.32	8.58	
4	498	84	552	208	52	2.13	.40	6.57	
4	760	320	1,207	124	31	5.13	2.58	3.77	
4	1,009	178	1,123	120	30	3.71	1.48	6.30	
4	1,146	96	534	68	17	3.15	1.35	5 55	
4	437	27	546	116	29	4.30	.23	20.20	
4	552	80	546	116	29	3 41	.69	6.82	
28	4,786	865	5,195	1,004	251	24.67	7.05	57.79	Total.
7	170.9	33.2	185.5	35	35.8	3.52	1.00	8.25	Average.

If comparison is made with hogs of like weight, having ground food, it will be at once seen that whole corn is less effective. But a part of the meal trials were in cool pens, as were many of the trials given for whole corn.

TABLE NO. 18.

SKIM MILK ALONE.

No. of animals.....	Weight of lot.....	Gain	Amount eaten	Days for one hog...	Days for whole lot..	Per cent. eaten to live weight daily.	Gain per day.....	Pounds of food to pound of gain.....	Remarks.
2	84	45	95.7	56	28	4.00	.81	2.12	
2	151	89	215.5	78	39	3.62	1.14	2.42	
2	249	56	339.7	86	43	3.17	1.23	3 20	
6	484	190	650.9	220	110	10.79	2.154	7.74	Total.
3	60.6	31.5	108.4	36.6	36.6	3.59	.71	2.58	Average.

The milk in this, as in previous cases, where it was mixed with meal, was rated at 10 per cent. solid matter and water. That is in ad-

dition to the dry matter of 100 lbs. of milk. I have rated it with water in the same proportion that corn and hay carry, so that, instead of getting 100 lbs. dry matter in milk, the pigs got by this table but little over 90 lbs. It seems that milk—skim milk—is the most efficient food fed, in proportion to organic matter given.

TABLE NO. 19.

MISCELLANEOUS FOODS.

Number of animals	Weight of lots	Gain	Amount eaten	Days fed for one hog	Days each lot were fed	Per ct. live w't eaten daily	Gain per day	Pounds eaten for one of gain	Remarks.
2	434	107	340	60	30	2.61	1.78	3.2	Corn & cotton seed meal.
2	184	93	388	106	53	3.98	.88	4.1	" " " " "
2	235	105	355	74	37	4.00	1.42	3.3	" " " " "
2	282	35	178	60	30	2.1	.58	5.9*	
2	53	14	90	72	36	4.7	.19	6.4	
2	250	110	400	84	42	3 8	1.31	3.6	
2	325	40	164	28	14	3.6	1.43	4.1	Sundry foods.
2	167	75	269	84	42	3.8	.89	3.58	
2	325	115	489	98	49	3.0	1.17	4.20	
8	196	93	370	28	14	12.5	.78	4.00	
26	2,453	787	3,043	694	347	44.09	10.43	42.38	
10	94.3	30.7	116.9	26.6	34.7	4.40	1.04	4.23	Averages.

* Roots—178 pounds dry matter, with ten per cent. water.

I fed the roots in the late fall, without other food, and the result for the per cent., 2.1, eaten is remarkable. For maintenance with little growth, many feeders of breeding sows have spoken highly of them to me. The result confirmed the statement. When fed alone they were too loosening.

The clear cob meal got by grinding cobs and mixing from 11 to 22 pounds of cotton-seed meal, bran or meal with it, has shown beyond question a decided nutritive value. Good growth was got, as is noted, on a small amount of food, of which over four-fifths was clear cob meal.

TABLE NO. 20.

CORN AND COB GROUND TOGETHER.

No. of animals...	Weight of lot....	Gain.....	Amount eaten...	Days for one hog.....	Days for whole lot.....	Per cent. eaten to live weight daily	Gain per day	Pounds food for pound gain.....	
4	742	184	1185	124	31	5.16	1.48	6.44	
4	994	180	1140	120	30	4.11	1.50	6.33	
2	296	162	674	108	54	4.22	1.50	4.16	
2	434	115	590	88	44	3.09	1.30	5.30	
2	100	50	185	88	44	4.20	57	3.70	
2	156	62	281	104	52	3.47	59	4.53	
16	2652	753	4055	632	255	24.25	6.94	30.46	Total
6	165.7	47	253	39.5	42.5	4.04	1.15	5.07	Average.

These trials with cob meal do not fairly represent it. The first two trials in this table were with the cobs merely cracked into small pieces by the ordinary iron mills, and proved very innutritious. The other four trials with fine ground cob meal gave a pound of gain for 4.42 pounds cob and corn meal showing as good results or better than with clear meal. Close observation of fine ground cob meal convinces me that it has a very high value, and that coarse cob meal has little value.

VALUE OF EXCESS FOOD.

But to return to maintenance rations, the following tables will note the value of excess food fed in amounts above such maintenance rations.

I have had to classify the growths according to weight of animals, inasmuch as the growth per day increases with size regularly until the animal reaches 200 pounds or more. Comparisons between a large animal using much food and a small per cent. per day cannot be made with small animals using large per cents. of food and little for a pound of growth. This increased growth per day is not seen in cattle, as they grow less per day as they grow larger. Possibly, it is this fact in regard to hogs, that I have never seen stated in swine literature, that misleads farmers into keeping older shotes than they should. The following tables show the relation of the amount eaten to growth, and illustrates a valuable truth:

TABLE NO. 21.

Relation to amount eaten to growth.—Weight under 50 pounds and gaining less than .75 pounds per day.

No. of Animals.	Weight of lot.	Per cent. eaten to live w'ght daily.	Gain per day.	Lbs. food for pound gain..	
3	143	4.18	.54	3.65	
2	90	5 02	.57	4.70	
2	56	5.80	.50	3.23	
2	93	5.30	.62	4.00	
2	61	7.08	.66	3.06	
2	100	4.20	.57	3.70	
2	37	7.25	.27	4.80	
2	53	4.70	.19	3.26	
2	60	3.70	.41	3.90	
2	61.4	5.48	.25	6.89	
21	754.4	52.71	4.58	41.19	
10	35.9	5.27	.46	4.12	Average.

TABLE NO. 21*a*.

Under 50 pounds and gaining .75 to 1.25 pounds per day.

No. of Animals.	Weight of lot.	Per cent. eaten to live w'ght daily.	Gain per day.	Lbs. food for pound gain..	
2	96	6.50	.85	3.60	
2	80	4.00	.80	2.12	
2	89	6.90	1.18	2 60	
2	96	4.00	.80	2.12	
2	76.7	7.75	1.20	2.85	
10	437.7	29.15	4.83	13.29	
5	43.7	5 83	.96	2.65	Average.

TABLE NO. 21b.

Under 50 pounds and gaining from 1.25 to 1.75 pounds per day.

No. of Animals.	Weight of lot.	Per cent. eaten to live w'ght daily.	Gain per day.	Lbs. food for pound gain..	
2	96	7.90	1.31	2.90	
2	98	8.10	1.35	2.90	
4	194	16.00	2.66	5.80	
2	48.5	8.00	1.33	2.90	Average.

TABLE NO. 22.

Relation of amount eaten to growth. Weight 50 to 100 pounds; gain under .75 pounds per day.

No. of Animals.	Weight of lot.	Per cent. eaten to live w'ght daily.	Gain per day.	Lbs. food for pound gain..	
3	151	4.85	.64	3.67	
3	152	2.43	.64	1.91	
2	135	3.51	.65	5.18	
2	156	3.47	.59	4.53	
2	110	4.87	.55	4.82	
3	151	5.84	.58	5.03	
2	138	4.48	.71	4.31	
2	101	5.88	.52	5.25	
19	1,094	35.29	4.88	34.70	
8	57.5	4.41	.61	4.34	Average.

TABLE NO. 22*a*.

Gaining from .75 to 1.25 pounds per day.

No. of Animals.	Weight of lot.	Per cent. eaten to live weight daily.	Gain per day.	Lbs. food for pound gain.	
2	160	5.65	1.07	4.22	
2	157	3.79	.89	3.33	
2	151	3.62	1.14	2.42	
2	167	3.83	.89	3.58	
2	178	4.64	1.05	3.73	
2	183	4.08	1.01	3.67	
2	184	3.93	.87	4.17	
14	1,180	29.59	6.92	25.12	
7	84.3	4.23	.99	3.59	Average.

TABLE NO. 22*b*.

From 1.25 to 1.75 pounds per day gain.

No. of Animals.	Weight of lot	Per cent. eaten to live weight daily.	Gain per day.	Lbs. food for pound gain.	
2	147	4.88	1.25	2.87	
2	103	7.08	1.46	2.50	
2	177	5.66	1.50	3.33	
6	427	17.62	4.21	8.70	
3	71.1	5.87	1.40	2.9	Average.

TABLE NO. 23.

Relation of amount eaten to growth.—From 100 to 150 pounds and growing under .75 pounds per day.

No. of Animals.	Weight of lot.	Per cent. eaten daily to live weight.....	Gain per day.	Lbs. food for pound gain.	
4	430	3.00	.74	3.40	
4	498	2.13	.41	6.57	
4	491	2.98	.64	5.69	
2	202	3.42	.62	5.54	
14	1,621	11.53	2.41	22.10	
4	115.8	2.88	.60	5.52	Average.

TABLE NO. 23*a*.

From .75 to 1.25 pounds per day gain.

No. of Animals.	Weight of lot.	Per cent. eaten daily to live weight.....	Gain per day.	Lbs. food for pound gain.	
2	247	2.91	1.05	3.40	
2	249	3.17	1.23	3.20	
2	287	2.78	1.01	3.92	
2	233	4.24	1.21	4.11	
2	267	3.72	1.16	4.27	
4	590	2.58	1.20	3.16	
16	1,873	19.40	6.86	22 06	
6	133.8	3.23	1.14	3.67	Average.

TABLE NO. 23*b*.

From 1.25 to 1.75 pounds gain per day.

No. of Animals.	Weight of lot.	Per cent. eaten daily to live weight.....	Gain per day.	Lbs. food for pound gain.	
2	296	4.22	1.05	4.16	
2	250	3.81	1.50	3.63	
2	282	3.72	1.25	4.18	
2	255	4.04	1.41	3.38	
2	257	4.13	1.56	3.40	
2	225	3.97	1.35	3.29	
2	228	6.27	1.67	4.25	
14	1773	30.16	10.04	26.29	
7	126.6	4.31	1.43	3.75	Average.

Above 1.75 pounds gain per day.

No. of Animals.	Weight of lot.	Per cent. eaten daily to live weight.. ...	Gain per day.	Lbs. food for pound gain.
1	227	5.28	1.96	3.05

TABLE NO. 24.

Relation of amount eaten to growth.—Weight 150 to 200, gaining less than 1 lb. per day.

No. of Animals.	Weight of lot.	Per cent. of live weight eaten daily.....	Gain per day.	Lbs. of food for lb. of growth	
3	478	3.34	.97	5.42	
2	375	1.94	.66	5.50	
2	358	2.47	.88	5.00	
7	1211	7.75	2.51	15.92	
3	173	2.58	.84	5.31	Average.

TABLE NO. 24*b*.

Gain from 1 to 1.50 pounds per day.

No. of Animals.	Weight of lot.	Per cent. of live weight eaten daily.....	Gain per day.	Lbs. of food for lb. of growth	
3	513	3.35	1.37	4.16	
3	528	3.01	1.41	4.48	
4	742	5.16	1.48	6.44	
2	325	3.00	1.42	4.00	
2	362	2.76	1.41	3.57	
2	347	3.23	1.15	4.81	
2	352	2.83	1.41	3.52	
2	372	2.57	1.55	3.53	
2	325	3 07	1.17	4.25	
2	321	2.70	1.00	4.33	
24	4187	32.88	13.17	43.17	
10	174.4	3.28	1.31	4.31	Average.

TABLE NO. 24*c*.

Gain of more than 1.50 pounds per day.

No. of Animals.	Weight of lot.	Per cent. of live weight eaten daily.....	Gain per day.	Lbs. of food for lb. of growth	
2	326	4.47	1 50	2.69	
4	760	5.13	2.58	3.77	
4	775	5.21	2.16	5.05	
10	1,861	12.81	6.24	11.51	
3	186.1	4.27	2.08	3.84	Average.

TABLE NO. 25.

Relation of Amount Eaten to Growth.—Weight 200 to 250 Pounds, and Under 1.50 Pounds Gain Per Day.

No. of Animals.	Weight of lot.	Per cent. live weight eaten daily.....	Gain per day..	Lbs. food for pound growth.	
2.....	434	3.09	1.30	5.13	
2.....	414	2.29	1.25	3.80	
2.....	412	2.90	1.35	4.33	
2.....	477	2.30	1.29	4.24	
8.....	1737	10.58	5.19	17.50	
4.....	217	2.64	1.29	4.37	Average.

TABLE NO. 25b.

Over 1.50 Pounds Gain.

No. of Animals.	Weight of lot..	Per cent. live weight eaten daily.....	Gain per day..	Lbs. food for pound growth	
4.....	924	4.11	1.50	6.33	
2.....	434	2.61	1 78	3.20	
2.....	440	3.04	1.55	4.32	
8.....	1798	9.76	4.83	13.85	
3.....	225	3.25	1.61	4.62	Average.

From the first four tables of the above group I compile another showing more clearly the relation of the amount of excess food eaten to growth. It is derived by assuming that 2 per cent. is the food of maintenance, and then ascertaining how much food was eaten by each lot in excess of this food, and how much it took of this excess food to make a pound of growth.

TABLE NO. 26.

Condensed Table Showing the Relation of Amount of Excess Food Eaten to Growth.

Group of smallest gains.		Group of next largest gains.		Group of third largest gains.		
Excess food used. Pounds....	Growth lbs.	Excess food used. Pounds....	Growth lbs.	Excess food used. Pounds....	Growth lbs.	
1.38	.61	1.88	.99	2.74	1.40	
1.17	.46	1.67	.96	2.91	1.33	
1.01	.60	1.64	1.14	2.92	1.43	
1.00	.84	2.23	1.31	4.22	2.08	
1.14	.62	1.85	1.10	3.19	1.56	Average.
.....	1.85	.....	1.66	.....	2.04	Lbs. for lb. of growth.

This table shows that the more food given up to enough to grow a shote one pound a day or a little more is given at a decided economy. It also seems to show that excessive growth is at great expense of food. This thought, I have before suggested, is true of cattle. I feel so far confirmed in this view that grew wholly out of my experiments that I am about convinced that there is a high degree of pressure in feeding that does not pay. This I am confident is true of the enormous amounts of corn given in rapid fattening in our State. Better a continuously good growth and no cramming periods.

The tables of this Bulletin, and especially this one, show the miserable economy of restricted diet. It is only on such diet that we are in need of wintering our shotes for the market.

REVIEW OF POINTS OF BULLETIN.

I. Maintenance ration is a variable amount, determined by age of animals and surrounding conditions, and ranges above and below 2 per cent. of live weight daily; but, under favorable conditions, may be materially under 2 per cent. of live weight daily, for a 120-lb. shote.

II. The food of growth is less than maintenance food, and varies from 1.43 lbs. to over 2 lbs. This fact requires that the days maintenance-food is given should be made as short as good feeding will allow. If we double the time needed to grow a shote, we use about three-fourths of the food given for maintenance, while on the other hand but little over one-half of the food goes for maintenance. With

middlings at $15 a ton, the best meal-feed, by the tables, 7 months lost time in marketing, costs in maintenance 39.3 per cent. of the sale value of the shote.

III. The more food given up to a little over a pound of growth per day, the more economical the growth—while excessive growth may not be so economical as the growth just stated.

IV. The growth per day increases with age up to at least 150 to 200 lbs.

V. The cheapest growth is made on young animals, gradually increasing with size until the maturing period sets in, when increase of cost is rapid.

VI. Skim milk and meals are the most effective rations fed. Middlings is the best single food; cob-meal, fine ground, is an efficient food, and equal to clear corn meal.

VII. For 56 pounds of food, 14 pounds of growth was got up to 200 pounds of live weight for average of all the trials. This growth at 4 cents a pound, gives 56 cents for the weight of food in a bushel of corn; middlings gave 15.3 lbs. growth for 56 lbs., or 27.4 lbs. for 100 lbs., which, at 4 cents, gives $1.09 for the 100 lbs. of middlings.

BULLETIN No. 29.

ROTATION OF CROPS.

BY J. W. SANBORN, DEAN.

AGRICULTURAL COLLEGE FARM,
COLUMBIA, MO, August 1, 1887.

W. POPE YEAMAN, LL. D., *President Board of Curators University State of Missouri and Agricultural College:*

SIR: By request of S. S. Laws, LL. D., President of the University of Missouri and Agricultural College, I address this bulletin to you as President of Board of Curators, in place of himself as President of the University.

Science teaches, and practice for ages has confirmed the economic value of rotation of crops. To measure in dollars, the standard gauge of the value of methods in farming, the value of rotation of crops in practice, a four year's rotation was laid out five years ago, or the month I took charge of the farm. At the same time after careful view of the soil, climate, and markets of Missouri, the whole farm was cut loose from its old methods, and a course of farming entered upon totally and radically different from that pursued by the farmers of the state. The methods adopted and freely presented through public lectures and public writings to the State, have met with more or less criticism, sometimes ridicule, as an exotic growth, and chimerical, when viewed from the standpoint of our practical farmers.

The system of farming thus inaugurated was not transplanted, but was organized upon the applied sciences, modified by local economic demands, to fit the demands of our farmers, and was intended to be wholly within their reach, and furthermore was believed to be calculated to fit precisely their demands, and to be a future aid to them.

The course of farming then entered upon had a value, to farmers of moderate means as well as to others, unusual to a public farm for economic tests, in that this farm was without good tools, was insufficiently stocked; its fields and pastures were in a bad condition for farming; stumps, bushes, poor fences, abounding in fields and pastures, and it had no capital, nor the power to borrow capital. Thus about the hardest conditions possible were to be overcome for success. One other drawback was possible, an era of low and falling prices. Agriculture has seldom had a worse period. The farm has received no money for four years; has expended from its own revenue, for the public, in round numbers, $2,000 for experiment work, and more than this for improvements, and has doubled its crop capacity. Its wheat this year was 774 bushels from 17 acres, or 45½ bushels per acre. Its hay is about or quite three tons per acre, while at this date its unharvested crops are heavy.

I trust that I shall not be misunderstood as either retorting or being boastful. An extensive experiment, revolutionary of western farm practices, and based upon science applied to agriculture, has been under trial and under public challenge, and in the interest of the public, and of the college, I speak directly and plainly. But this general success, which in part rests upon crop rotations, I use to emphasize the value of the experiments that I am to review in this bulletin. In two years more the effects of the first round of our six year's farm rotation, and its allied practices, will have culminated, when I hope that a full statement of its methods and results may, by some one for this college, be given to our farmers. So far it has been singularly successful, and shown to be easily made use of by others, for none can be worse handicapped who have any start, and I repeat, I merely generalize, that the purposes and value of the rotation trial by plats, may be understood in advance, that their bearings in actual practice, be not lost to our farmers through a false belief that they are merely calculated to make pleasing theories look more probable than they are likely to be actually valuable in practice.

PHILOSOPHY OF ROTATION.

As the experiment work of this college is carried forward in the direct interest of economical farming, I will turn aside from the direct

function of a bulletin, which is to relate the results of investigations, to state the reasons, in part, upon which rotation is based, without, however, going into evidence in support of said reasons.

I. Rotations are valuable because plants vary in the area of the soil in which their roots grow, and from which they derive the sustenance of the plant, thus more completely utilizing the soil within their reach.

II. There is a remarkable variation in the power of plants to appropriate the various elements of plant growth, due, at least in part, to the character of the acids secreted by their roots. Thus one plant, like clover, has a high power of gathering nitrogen, and another, like wheat, a very low power; and, when as under number

III. Plants vary in their weight of roots, as an illustration clover, carrying several times the weight of roots that wheat does, it will be seen that, inasmuch as clover roots are very much richer in nitrogen than wheat, and carry enough nitrogen to grow a crop of wheat, that wheat will most advantageously follow clover. Thus, likewise, other plants follow each other advantageously.

IV. Rotation of crops baffles, in a large measure, the root enemies, both insect and fungus, that prey upon them. Each plant having its own peculiar enemies, changing of plants removes them to fields unoccupied by such enemies. This is true of the enemies of the above-ground growth of plants to an important degree.

V. Plants vary in the amounts of the varying elements of nutrition actually taken up in growth; thus, while wheat takes only 1 1-4 pounds of potash for every pound of phosphoric acid, potatoes take 3 1-4 pounds of potash for each pound of phosphoric acid. Continuous growth of potatoes would exhaust the potash of the soil or of supplied manure long before the phosphoric acid would give out.

VI. The leaves of plants vary in their power of gaining food and of vaporizing water, and are roughly divided into broad and narrow leaved.

VII. Leaves vary in their season of active growth. Those plants maturing in midsummer and early fall generally gather nitrogen (corn and turnips are good examples), following in their growth the decomposing influence of the sun, more easily and fully than other crops do.

VIII. Rotation conserves soil fertility and yet aids in soil decomposition by alternation of grass, or cover crops and hoed crops. Under a continuation of plow and tillage crops leaching, volatilization and washing of fertility is rapid and may be or is more than carried away by crops, especially so of nitrogen.

IX. Rotation of crops distributes labor over the year and thereby economizes labor and gives regular help and aids in the solution of the labor problem of the farm.

X. Rotation is the system best calculated for home consumption of crops and return fertilization of the farm.

XI. Practice of 2,000 years confirms the value of rotation. Each of these factors has its bearing that I cannot here present, but altogether afford very strong and almost, if not quite, imperative reasons for rotations.

ROTATION TRIAL.

The trial was made on upland long in use and whose last crop was timothy. Soil, a clay loam over a limestone formation; subsoil so compact that surface ponds readily retain water. Both the land at the beginning and end of the first rotation period and the crops were unananlyzed—funds not being available for the purpose. For the gratification of the friends of the college, I will state that $1,000 yearly has been devoted by the State to this work, while a good equipment of the farm, horticultural department, and veterinary laboratory has been provided for. In a few months these means will all be available for better or fuller work.

The five plats of 1-10 acre each were treated as follows:

Plat 1. Wheat after wheat—unmanured.

Plat 2. Wheat after wheat—manured—six tons per acre yearly.

Plat 3. Crops, wheat, clover, corn, potatoes and wheat—six tons manure per acre yearly.

Plat 4. Wheat, corn, wheat, corn, and so on—six tons manure per acre.

Plat 5. The same as plat 3, except that it was unmanured.

I will be seen that the full rotation period is four years, when the same round is to be repeated again.

The above rotation is not a good type of a scientific rotation, which should alternate shallow and deep rooted plants, broad and narrow leaved plants, and plants of unlike feeding characteristics, and should not have a succession of hoed crops. Neither is it a good typical practical rotation. Thus no one will look to this rotation for an example to literally follow.

The principal that rotations are successful was the one idea sought, and with some necessary impatience it was laid out to obtain results as quickly and directly as possible. For this reason the rotation started with all plats wheat, in order that at the fifth year a clear contrast with the first year could be made.

Notwithstanding the apparent evenness of the ground, the first crop was uneven. This disappeared before the conclusion of the trial. The second year the weight of a couple of plats was lost, and so all are omitted for this year. The third year the winter was severe, and killed the wheat severely. In its room timothy came and was allowed to grow. This, and the wheat, were all weighed in together, with the wheat untreshed. The following table gives the results:

TABLE OF YIELDS PER ACRE.

Plats...	1883.		1884.		1885.		1886.		1887.		Total yield in pounds.
	Wheat bu.	Straw lbs.	Wheat	Straw	Wheat	Straw lbs.	Wheat bu.	Straw lbs.	Wheat bu.	Straw lbs.	
9	18.91	3745	....	.....	.....	3560	13.93	1310	13.91	1355	12,775
10	20.16	3330	.....	.....	.. ..	3760	23.66	2180	24.28	1995	15,351
11	15.66	2790	.....	.....	Corn lbs. 4270	Fodder lbs. 5919	.....	Potatoes. lbs. 6460	38.08	3867	26,561
12	9.66	1700	.....	.....	.....	Wheat and hay lbs. 5220	Corn bu. 21.10	Fodder lbs. 290	32.76	2372	16,347
13	4.66	1380	.....	....	Corn lbs. 3200	Fodder lbs. 5750	.....	Potatoes. lbs. 3200	30.16	2465	18,102

OBSERVATIONS.

I. All the series of plats tell one truth, and that in favor of rotation.

II. The total yield of the rotation-plats or No. 3, for four years, is greater than No. 2, or the non-rotation plats, by 45.6 per cent., after properly reducing the potato rotation crop by over 4,000 pounds.

III. The crop of wheat for 1887, or the opening of the second rotation round of four years, when all of the plats are in wheat, is the critical test, and the one sought for. This gives the following results:

a. The four years' rotation plat gives 67 per cent. more wheat than the plat where wheat follows wheat, notwithstanding this is one of the best wheat years known in the history of the State.

This rate of increase applied to the State would make in an average year 13,000,000 bushels of wheat above the present yield, or would add to a farmer's revenue, who receives $1,000 in wheat money, $670.00.

b. The two years' rotation, or plat 4, increased the crop over the non-rotation yield 35 per cent. This shows that a short rotation, in accordance with general laws, is not as efficacious as a longer one, yet is a great gain.

c. Four years' rotation is shown to be more efficacious than on manured non-rotation crop—contrast plat 5 with plat 2 for 1887. It cannot be said that manure is of no use as an explanation of the result, as the unmanured non-rotation plat is but about one-half the yield that the manured non-rotation gives, or as 13.91 bushels is to 24.28 bushels.

d. Four years' unmanured rotation is about as good as a two years' manured rotation. These results cannot be said to be due to plat variation, as the poorest yield the first year was gained on the rotation plats. Furthermore, all the plats tell one story, and the five years' aggregate is in one direction. Again, these plats are joined by many other plats in wheat after wheat, both manured and unmanured, and none of them came up to the rotation plat. Again, the whole farm is farmed on a six years' rotation scheme better organized than these plats were. It is corn following timothy, then oats, clover, wheat, timothy fifth year and timothy sixth year. The crops on the farm, as noted, are superior to the plats and its tillage area is now very productive. While rotation is only one of the important factors in our farming, yet I am entirely confident that the adoption of systematic rotation of crops by our farmers will do much to add to their comfort and wealth, indeed, revolutionize our conditions.

BULLETIN No. 30.

FERTILIZATION..

BY J. W. SANBORN, DEAN.

AGRICULTURAL COLLEGE FARM,
COLUMBIA, Mo., October 18, 1887.

W. POPE YEAMAN, LL. D., *President Board of Curators University State of Missouri and Agricultural College:*

SIR—For five years experiments have been carried forward on the College farm with chemical and yard manures on about 30 plats of one-tenth of an acre each. But one report has been made of these trials, and that one was for the first year, and was numbered Bulletin seven. In that Bulletin was set forth a few fundamental facts regarding chemical fertilizers. It will be necessary to restate, in part, those facts that pertain to chemicals alone.

At the outset I wish to state that, while I used chemicals by the car load for years, and am an emphatic believer in their economy for the older sections of the country, I do not believe that the prices of staple crops in Missouri justify their use, except under well-defined limitations, which admit of their use only under exceptional conditions. Aside from the restraining influence of market rates of chemicals and crops on the use of chemicals, the more important fact that the saving of the wastage, as now conducted, of our stock excrements, will cost but a fraction as much as the plant food secured in purchased chemicals.

Events have enforced the profound need of the utmost economy of stock manures, and their intelligent use. Let this cheapest of all sources of plant food (that is, cheapest under our conditions in Missouri), be first exhausted before we look for costly, outside sources.

Why then keep up these costly and painstaking experiments with chemical manures?

First. Because chemicals are being advertised for the use of our farmers, and the disposition to use them is increasing, as manifested by actual sales, and the increasing letters of inquiry received at this office.

Second. They have their place of profit in our State.

Third. The trials are made as illustrative of a method of inquiry into the needs of our soil, and as aids in settling certain principles of fertilization.

Fourth. As a means of instruction regarding their action, purchase, economic value, etc., in order that costly errors may be avoided, which some of our people are making, and which more are about to make.

Fifth. For their direct use to this farm as a means of ascertaining the needs of our soil.

EXPLANATORY NOTES.

Chemical manures are the product, in part, of the manufacturer's art, and their market value is determined by their composition, while their economic value is determined by the character of the farm of the purchaser, and the crop he proposes to raise. The former, or market value, can be ascertained by multiplying the number of pounds of phosphoric acid, potash, and nitrogen found in a ton (the law of most States where chemicals are sold requires the manufacturer to state the composition of his fertilizers, and enforces said composition) by the market rates of the elements of plant food contained in the fertilizer. Thus if a ton of superphosphate has a stated composition as follows: Phosphoric acid, 10 per cent.; potash, 2 1-2 per cent.; and nitrogen, 3 1-2 per cent., the following results will be got, at the present rates of these materials in New York, which are for phosphoric acid, 8 1-5 cts. per lb., potash, 4 1-10 cts. per lb., and nitrogen, 16 cts. per lb:

2,000 lbs. by 10 per cent. equals 200 lbs. phosphoric acid at $8 45.....	$16 50
2,000 lbs. by 2½ per cent. potash equals 50 lbs. at 4 1-10 cents.....	2 05
2,000 lbs. by 3½ per cent nitrogen equals 70 lbs. at 16 cents.....	11 20
Total.....	$29 75

This principle, using the rates prevailing for these elements of plant food for each year as they fluctuate (the phosphoric acid and ni-

trogen should be cheaper in the West than in the East), will enable any one who can reckon to tell the value of the brand he is buying. If it is offered at $35, with the above composition, it is dear; if at $25 it is cheap. This is, of course, based on the honesty of the seller, or the care taken to verify the composition by the State chemist's analysis.

Instead of buying the compound fertilizers as above intelligence is rewarded in buying what are popularly known as the raw chemical fertilizers; that is, the nitrogen by itself, the potash by itself, and the phosphoric acid by itself. By this means they are bought for less, are more certain to be honest, and one can use those which his farm needs, without the necessity of paying for those which his farm does not need. This brings me to

THE ECONOMIC VALUE OF FERTILIZERS.

This value is independent of the markets and dependent upon local prices for crops and the farm upon which they are used.

To make this clear I will state a few well-recognized truths in chemical farming. Fourteen elementary materials enter into all crops of which any one of ten of them not being in the soil will result in the total failure of the crop to grow. But of these ten needed materials all arable soils are held to have them all in abundance for crops save three. These three are nitrogen, phosphoric acid and potash, in their forms known to the fertilizer trade. But of these three materials only one on some farms, two on others, and all three on most farms are needed. A farm formerly under my charge needed potash only for good crops, another needed phosphoric acid mainly, but for large crops some potash, while this college farm seems to need them all for corn and only nitrogen for wheat. But again the demanded chemicals do not depend upon the farm wholly, but vary with the crop. Wheat and the grasses call heavily for nitrogen. Clover, beans, etc., call for potash, while corn, turnips, etc., ask for phosphoric acid in artificial supply.

The economic value of chemicals will then be measured much also by the intelligence with which we adjust the fertilizer bought to the soil and crop grown, as well as upon buying in cheapest form.

These fundamental truths regarded, places will be found in Missouri for chemicals; otherwise I believe that they had better not be touched for some years to come.

ILLUSTRATIONS.

To make clear the above points in the behalf of many inquirers, and of all interested, I will state a few conditions.

To grow 50 bushels of corn and its fodder will require approximately 30 lbs. phosphoric acid, 65 lbs. of nitrogen and 80 lbs potash.

30 lbs. phosphoric acid at 8 1-5 cents	$2 46
80 lbs. potash at 4 1-10 cents	3 28
65 lbs. nitrogen at 16 cents	10 40
Total	$16 14

The corn and fodder would be worth about $20. This would not do. But if, as many claim, no nitrogen need be used, and it need not be on some farms, the phosphoric acid and potash would not cost but $5.74, and would pay better. Yet as these amounts of minerals could not be counted upon to give over 30 bushels of increase above what nature would have given on the same soil even under favorable conditions, and if we regard only the corn as of value, as is the method of some, we have 30 bushels at 30 cents, equal to $9, and 1 1-2 tons of fodder worth $4.50, and is the best to be hoped for with us. Now suppose that a farm only needed phosphoric acid, costing $2.48 to increase a crop 30 bushels, then it would be within the region of profit. I could count upon 25 bushels of corn increase in actual practice for every $3 of potash on a farm once under my charge. This paid well. Comparatively few such favorable chances will be found.

If we turn to wheat the outlook is more favorable. Twenty bushels of wheat contains about

35 pounds nitrogen at 16 cents	$5 60
20 pounds potash at 4 1-10 cents	82
16 pounds phosphoric acid at 8 1-5 cents	1 31
Total	$7 73

If we ascribe 12 bushels of the 20 to the chemicals, then at 80 cents for wheat and straw it equals $10.40.

If with this crop one element will greatly increase the crop or even two of them do so, a margin is possible.

But one more, 150 bushels of potatoes contain

Nitrogen, 33 pounds at 16	$5 28
Potash, 52 pounds at 4 1-10	2 13
Phosphoric acid, 17 pounds at 8 1-5	1 40
Total	$8 81

If we ascribe 100 bushels to the chemicals over and above what the soil would yield alone we have a value of $30 to $40. If we can strike out the nitrogen costing $5.28, we get the crop for $3.43.

Now as a matter of fact I got the following increase over soil upon which no fertilizer was applied by the use of the following chemicals: Eighty-two bushels of potatoes as an average yearly for three years for 11 lbs. phosphoric acid costing 90 cents, and 35 lbs. potash costing $1.44, or a total of $2.34 cents.

In market gardening greater extremes are met with.

The above considerations illustrate my reasons for saying that there are crops and soils upon which chemicals will pay with us. But as these soils are not the rule and our main crops not those profitable for chemicals (hay would be less profitable) it would be seen why I do not advise chemicals except in a limited way by right purchase and right use, and then only after the stock manure has been saved.

HOW TO ASCERTAIN THEIR PROPER USE.

The system, first inaugurated by Ville, for the French government, is as yet the only practical way for farmers to ascertain the necessities of ther soil, and consists of using all three (Ville used 4, adding lime, we do not need it in Missouri as direct plant food) elements said to be liable to be needed by soils and in turn omitting one of them in some combination. The tables following will illustrate the method in its simpler form, for it can be made more complex.

THE TRIALS.

The soil is clay loam with compact sub-soil — time, five years. Crops, wheat and corn. Previous crop, grass. The potash salts were bought in the form of muriate of potash, containing 51 pounds potash for 100 pounds salt. The nitrogen in the form of sulphate of ammonia and in the form of nitrate of soda for the last two years, containing 15 1-2 lbs. nitrogen to 100 lbs., and the phosphoric acid in the form of dissolved bone-black, varying from 15 to 35 per cent. phosphoric acid in

the varying years. They were bought in New York. One year the wheat froze out and timothy came in (wheat turned to timothy instead of cheat) and was weighed in lieu of wheat.

The crops were not large, for, as I have shown in Bulletin 29, a crop following itself cannot be as good as when following other crops. Yet we deemed continuous crops necessary for our purpose in order to observe the ultimate effects of the various manurings, and the kinds our soil most needs, and their relation to corn and wheat on the same soil. Several of our western experimenters have published exceedingly discouraging results from the use of fertilizers, where they were used upon fresh soil for one year.

CROP WHEAT.

Plats.....	1883.		1884.		1885.	1886.		1887.		Average five years.		Lbs. straw to bu. wheat.	Fertilizer used.
	Wheat. bu.	Straw. lbs.	Wheat. bu.	Straw. lbs.	Timothy. lbs.	Wheat. bu.	Straw. lbs.	Wheat. bu.	Straw. lbs.	Wheat. bu.	Straw. lbs.	Pounds.	
1	12.5	2120	21.7	2700	*3560	19.3	1840	25.	1300	19.6	2304	101.4	67 lbs. Nitrogen; 51 lbs. Potash; 25 lbs. Phos. Acid.
2	16.2	2345	16.	2900	4050	25.9	2700	22.2	1470	20.1	2603	117.1	6 tons yard manure first year, 10 tons afterward.
3	15.6	2360	17.7	2758	*2800	13.7	1680	16.	1930	15.75	2306	138.4	44⅔ lbs. Nitrogen; 51 lbs. Potash; 25 lbs. Phos. Acid.
4	4.	1040	4.9	1000	2660	9.2	1310	11.3	1050	7.3	1392	149.	No manure.
5	10.	1925	11.	1950	*3460	12.5	1810	14.	1605	11.9	2150	153.6	22⅓ lbs. Nitrogen; 51 lbs. Potash; 25 lbs. Phos. Acid.
6	8.8	1330	8.9	1465	*3540	13.	1470	12.5	1110	10.8	1783	124.4	51 lbs. Potash; 25 lbs. Phos. Acid.
7	8.8	1570	8.3	1400	*3760	12.	1555	13.7	1130	16.7	1883	132.	25 lbs. Phos. Acid.
8	8.8	1470	8.7	1575	2100	13.	1720	13.3	1220	10.9	1597	135.6	No manure.
9	.....	.....	11.4	2935	4000	13.	1545	21.5	2312	15.3	2723	150.	67 lbs. Nitrogen.

*The Phosphoric Acid was used 36 lbs. in 1885 to plat instead of 25 lbs. in plats where used before, and Nitrogen 62 lbs. for 1886 and 1887.

OBSERVATIONS.

I. The season of 1882-3 was a poor or dry one; of 1383-4 the exposed plats suffered some by freezing; 1884-5 practically all killed by winter freezing; of 1885-6 a good season by both moisture and frost, as was the past season.

II. It will be noticed that the chemicals gave practically the same average yield of wheat as yard manure and less of straw, and that in good years of plenty of moisture that the chemicals excel the yard manure in wheat yield, while it is the reverse in dry years. This might be expected from the the influence of the organic matter of the manure.

III. A comparison of the plats shows that the gain in yield over the nothing plat is mostly, or possibly, wholly due to the nitrogen. It is true that plat 9 having only nitrogen does not do as well as plat 1, treated with nitrogen and minerals, but this plat was not started until one year after the others, and like the others, gained each year upon the others, just as the others gained over the minerals. This shows the need of extending observations of the results of chemicals on the same ground before drawing unfavorable conclusions regarding their value or functions.

IV. If we ascribe the gain of lot 1 over lot 4 to the use of nitrogen, regarding straw as worth $3 a ton then the wheat got extra by the use of nitrogen cost 60 cents a bushel. In the East, where wheat is higher, it might answer. For spring wheat less nitrogen would, however, be needed.

V. Plats 6, 7 and 8 gave almost identical yields, not only for the first year, but for the five years, and afford one of the best illustrations I have seen of the non-efficacy of a fertilizer, or that chemicals may be uselessly used. It is such misuse or unintelligent use of chemicals that gives rise to the cry that chemicals are valueless. We cannot as yet say these two elements used on plats 6 and 7 are in abundance for wheat on our soil. If it appears in the future from lot 9, as it is likely to, that the entire gain of the wheat crop over the nothing plat was due to the nitrogen, we shall conclude that it is useless to use potash or phosphoric acid for wheat on our soil. It is to be borne in mind that it is yet possible that they, or the two materials used, fail to manifest themselves, from the fact that nitrogen is so in want for wheat that the plant can make no extra growth from its need, while the nitrogen would not make a maximum growth without the aid of these minerals, as there might be minerals enough for a minimum crop, or a

crop of 10.7 bushels, as found, and yet not enough for 19.6 as got by lot 1. Lot 8 is the fair comparison plat to lots 6 and 7, as these lots seem to be a little more fertile than lot 4. Lot 15 was on end of 1, 2, 3, 4 and 5, while the other lots run parallel to each other, being 2x8 rods.

THE CORN PLATS.

The corn plats are in the same field as the wheat plats and are of the same size, age, etc., being corn after corn, each plat receiving the same fertilizer year after year.

Plats.....	1883.		1884.		1885.		1886.		1887.		Bushels average, 5 years.	Av. lbs. corn fodder, 5 y'rs	Fertilizer.
	Corn, bushels.	Corn fodder. lbs.	Corn, bushels.	Corn fodder. lbs.	Corn. bu.	Corn fodder. lbs.	Corn, bushels.	Corn fodder. lbs.	Corn. bu.	Corn fodder. lbs.			
1	15 tons of yard manure 26.7 41 lbs. nitrogen 75 lbs potash 27 lbs. phos. acid	2,300	15 tons manure. 54.6 62 lbs. nitrogen 102 lbs. potash 70 lbs. phos. acid	5,600	32.6	† 5,480	15 tons manure 35.3 46 lbs. nitrogen 100 lbs potash 36 lbs. phos. acid	3,800	10 tons manure 32.9	3,760	36.4	4,188	15 tons yard manure.
2	20.8	2,260	54 9	4,020	50	6,700	37.3	4,700	26.1	*4,120	27.8	4,360	No manure.
3	No manure 27.6 20½ lbs. nitrogen 75 lbs. potash 27 lbs phos acid	2,440	52.4 31 lbs nitrogen 102 lbs. potash 70 lbs. phos. acid	3,600	38	3,500	20.5 23 lbs. nitrogen 100 lbs. potash 36 lbs. phos. acid	2,500	11.8	2,360	30.	2,868	
4	25.3 75 lbs. potash 27 lbs. phos. acid	2,540	58.5 102 lbs potash 70 lbs. phos. acid	4,400	47.9	5,600	33.5 102 lbs. potash 36 lbs. phos. acid	4,900	20.5	4,400	37.1	4,368	
5	29.1 27 lbs. phos. acid	2,500	54.4 70 l s. phos. acid	4,400	35.9	5,200	28 36 lbs. phos. acid	4,200	17.7	4,580	33.	4,176	
6	37.2 27 lbs. phos. acid	2,760	59.6 70 lbs. phos. acid	4,600	40.7	4,400	31.6 36 lbs. phos. acid	3,900	20.5	4,240	37.9	3,980	
7	30 lbs. nitrogen 36.9 75 lbs. potash	2,640	41 lbs. nitrogen. 60 102 lbs potash	4,100	44.4	4,330	34 lbs. nitrogen 34.1 100 lbs. potash	4,010	23.9	3,900	39.9	3,796	
8	30 lbs. nitrogen 38.9	3,140	41 lbs. nitrogen 63.6	5,040	59.5	5,350	34 lbs. nitrogen 26.	3,500	13.5	4,400	40.3	4,286	
9	33.4	2,640	55.2	.....	40.5	3,740	20.4	2,500	11.3	3,080	32.	.....	No manure.
10	34.5	3,140	52.1	3,060	47	4,460	28.9	3,460	15.2	3,400	30.2	3,504	Ashes, 2 bu.
11	.....	.....	.....	.....	.....	.....	20.4	2,100	16.4	3,200	.....	3,200	30 lbs. plaster
12	.....	.....	.....	.....	.....	.....	35.6	2,100	22.3	3,830	.....	3,830	30 lbs. lime.
13	.....	.....	.....	.....	.....	.....	26.4	4,400	21.	4,600	.....	.....	30 lbs salt.

† Fertilizers for 1885 same as for 1884, except that 50 lbs. phosphoric acid was used per acre in lieu of 70 lbs.
* Fertilizers for 1887 same amounts as for 1886.

REVIEW OF DATA.

I. The season of 1883 was a very poor corn year as have been the past two years.

II. The influence of the chemicals and yard manures are not visible the first years, but begin to stand out sharply during the last two years. When corn is forced to follow itself it soon loses its power to gain the nutrition for a good crop.

III. The value of minerals is now obvious and that of nitrogen more obscure. This is not inconsistent with the wheat plats. Wheat grows during cool weather when oxidation is at its minimum, while corn grows in the hot months when soil decomposition is at its maximum. As most of the available nitrogen to a plant comes from the decay of the organic matter of soil and as wheat needs much of it, the results above are not strange. Other factors than season are also involved.

IV. The lime and salt plats began in 1886 and followed wheat, and hence had the advantage of a rotation in part. It is, therefore, too early to draw any conclusions from their use. These and plaster are indirect fertilizers acting by aiding soil decomposition. The chemical fertilizers before used act directly as plant food by feeding plants from their own substance, while lime, salt and plaster put the soil, by aiding decomposition, in condition to feed the plant. They hasten soil exhaustion and hence can bear no comparison as to price and value with the plant nutrient fertilizers for the average soil. The salt and lime should be used only in a very guarded manner, they are often of value. Our farmers are disposed to buy those materials on account of their low value. They will be continued in use on the college farm until their influence on the crop and on the chemistry of the soil can be studied.

V. These facts related, so far as this farm is concerned, show that the system of management outlined in Bulletin 29 is much more satisfactory for crop production than the purchase of chemicals.

The adjoining plats to these corn and wheat plats are those related in said Bulletin, and which have given such satisfactory returns by rotation.

In conclusion, I renew my advice to our farmers to attempt to use chemicals (I do not now include lime, plaster or salt) only after intelligent buying, a careful study of your soil by tests similar to those given in this bulletin, and then to horticultural crops mainly, including potatoes. When wheat approximates a dollar a bushel, or where the minerals are wanting, then my advice will not apply, nor will it apply to soils deficient in potash or phosphoric acid to a marked degree.

CORN PREMIUMS.

The State Board of Agriculture. for the purpose of collecting valuable information, and to stimulate better methods of corn culture in our State, which now averages but twenty-six and a fraction bushels of corn per acre, an amount too small to return a profit for its growth, offered the following premiums, on the following conditions, namely: One hundred dollars for first premium, fifty dollars for second, and twenty-five dollars for third premium, first, second and third largest yields of corn raised in Missouri in 1887. To this premium, Abeil Leonard, member of the Board from Saline county, offered $100 in addition, open to the competition of the State, and which was divided into first, second and third, as is the Board's premium.

CONDITIONS.

I. The area under competition shall be five acres.

II. The rows, neither at their ends or sides, shall reach within two feet of the outside of the five acres.

III. The ground shall be measured by the county surveyor, or some competent person deputized by him, and shall be duly certified.

IV. The distance apart of the rows and hills shall be stated in the returns of the crops, also the actual number of plants to the acre at harvest, both barren and bearing plants.

V. There shall be given also the depth and time of plowing, the time of planting, the number of times cultivated, the depth of cultivation, or whether deep or shallow, the depth of planting, the variety of corn used, the measurement and description of an average ear, with the height of stalk.

VI. The previous crops grown for three past years shall be stated, together with a description of the soil. In case it is required, a sample of the soil upon which the best crops are grown, shall be forwarded for analysis, at our expense for transportation and analysis.

VII. A careful statement shall be made of the manuring resorted to to increase the crop, both in kind and quality, including method of use.

VIII. The crop of corn is to be, all of it, actually weighed by a justice of the peace, or some one appointed by him, and shall be duly certified to. On or before the 20th of October, and on the day when the harvesting of the corn begins from the center two rows twenty hills in from the end, fifty lbs. of ear of corn shall be gathered, and every ear shall be taken on the plants until fifty lbs. are gathered. This corn shall be weighed accurately and forwarded by express to the Secretary, to test for moisture. By this means, justice will be secured to all, and the actual yield of dry corn per acre ascertained, perhaps for the first time. No corn shall be harvested when moist from rain or dew.

IX. Before the prize is awarded, the member of the Board nearest, or if inconvenient for him, some other member of the Board shall visit the farms of those likely to receive the award, and satisfy himself regarding the fulfillment of the conditions laid down.

X. All competitors are expected to add any information not laid down in these rules that will be of value to the public.

XI. The public are again requested to add to these premiums in order to secure a sharp competition, and to do a great public good. Some parties are expected to add premiums to the above, provided it is taken by any one of their county, while others will give it to the best crop of their county competing for the prize. I ask that all such extra prizes be reported to me for publication and use.

The premiums are again renewed for the season of 1888 the conditions to remain the same as for 1887, and it is sincerely hoped that hundreds of corn growers will compete for the prizes.

Quite a number of farmers from different sections of the State gave notice in early spring that they intended to enter the contest and several planted their corn with that expectation, but the severe drouth so restricted its growth that the design was abandoned.

Only three competitors were left when the time came for making their returns to this office, and in the following table and notes is given the yields and full particulars of culture, manuring, etc.:

CORN PREMIUMS.—YIELD PER ACRE.

Name of competitor	Postoffice.	County.	Yield per acre shelled corn—bushels	Cob—per cent. by weight	Distance apart in rows—feet		Distance apart in hill		No. of plants in hill	No. plants per acre.		Depth of breaking—inches	Height of stalk.	Cultivation	Variety.
										Bearing	Barren.				
					ft.	in.	ft.	in.							
Wm. & H. Howard.	Marshall	Saline	93.85	17.56	3		3		3 to 4	11,696	683	4 to 5	10	.....	Yellow Dent.
A. B. Matthews	Kansas City	Jackson	76.82	15.59	3	9	3	9	3 to 4	.....	.....	6	7½	Deep.	Mammoth Cuban.
H. T. Wright	Providence	Boone	69.76	17.89	3	8	3	8	3	9,644	103	5	10	Deep.	Yellow Dent.

The sample sent to this office, in compliance with Rule VIII. of the foregoing conditions was reduced ten per cent. moisture and on this basis the yield per acre for the whole five acres was calculated with the result as above given.

Wm. and H. Howard, of Saline county, therefore, received the first premium or $100, and four-sevenths of the special prize of $100 given by Mr. Abiel Leonard. A. B. Mathews, of Jackson county, was awarded the second premium or $50, and two sevenths of the special prize, and H. T. Wright, of Boone county, secured the third premium or $25, and one-seventh of the special.

It should be borne in mind that the above yields were secured in an unusually dry season. The average yield per acre for the State being only 22.8 bushels and represents 63.4 per cent. of a full average crop.

Below is given a detailed statement of character of soil, culture, manuring and other matters of general interest pertaining to corn growing.

HOWARD BRO'S. STATEMENT OF CULTIVATION, ETC.

The ground had been in meadow and pasture for thirteen years previous to breaking up for this crop—March, 1887. About four years since $50 was expended in manuring the ground. Horse manure was used and was obtained from the livery stables of Marshall. The manure was hauled on the ground and thrown in piles and spread over the grass in the spring.

The ground was plowed for the present crop four or five inches deep in March, and immediately dragged both ways with a heavy double drag, sixteen feet long, and requiring four horses. It was next cut each way with a sod cutter and was again dragged each way as before stated. Just before planting, the ground was dragged again, but this time much less weight was used.

It was then marked off with the rows exactly three feet apart each way and perfectly straight. The planting was done by hand, using spades to cut entirely through the sod, and a boy dropped the seed in the hill as the men spaded it. Finished planting April 19.

As soon as well up, cultivated in the center of the row with long, narrow bull-tongue plows, and immediately cross-plowed with tongueless cultivator. Plowed it four times with tongueless cultivator and followed each time with a drag drawn by one horse. Boys, eight or ten years old, did the work.

Corn replanted first of May, and suckered and thinned to from three or four stalks in a hill. At the same time all weeds were removed from the hills and this work was thoroughly done twice. The drag kept the ground free from weeds and grass and aided the plowing by leaving the ground perfectly smooth.

Seed used, Yellow Dent, having previously taken four premiums at the Saline County Fair and first premium at the *Prairie Farmer's* (Chicago,) corn show in November, 1886.

I have used the drag for a number of years in preparing ground for corn, and believe it is one of the greatest labor-saving implements in use, as it pulverizes the soil better than a roller and kills all weeds. It is not expensive and any farmer can make one.

STATEMENT BY A. B. MATTHEWS.

In conformity with the conditions above Mr. A. B. Matthews makes the following statement concerning his five acres in addition to that given in the preceding table of yields:

The land on which this corn was grown had been an exceedingly wet piece of bottom, so wet, in fact, that on the preceding year I did not raise enough to pay taxes. I then tile-drained the land, placing the tile about forty inches deep. The latteral drains are sixty feet apart.

This enabled me to plow the corn much sooner after a rain than land on the hill could be plowed which was not drained.

The land had been grown in corn for the two years preceding this crop, and prior to that had been in a swamp for millions of years perhaps.

Forty-eight loads of well rotted barn-yard manure were well scattered on the ground after it was plowed.

Quality of soil, vegetable mold overlying what is commonly called joint clay subsoil.

Land broke six inches deep on April 11th and 12th. Planted from three to four grains in the hill and three inches deep on April 28th.

Corn cultivated May 6th, harrowed with a smoothing harrow May 16. Plowed the corn May 23d, five inches deep; June 14th, five inches deep; June 24th, five inches deep; (I think this was too deep for this time of the year); July 16th, plowed with double shovel about three and a half inches. Quite a number of hills were missing, but am not positive as to the number. Variety of corn, Mammoth Cuban, for a bushel of which I paid $23, and express. Not being familiar with the habits of this corn, the mistake of planting three or four grains to

the hill was made. It yielded, I think, fully one-third more than the Evans corn, which grew in the same field and under similar conditions of soils, etc. Nearly every stalk of the Mammoth Cuban bore two ears and some three, but just as it was filling out the memorable two days of hot dry winds came and injured it very much.

STATEMENT BY H. T. WRIGHT.

Accordingly, H. T. Wright, of Boone county, having secured the third prize, makes the following statement: Soil black gumbo; land plowed in October, 1886, five inches deep; planted April 9th three inches deep, with check rower, three feet and eight inches apart each way; cultivated six times with plow; five times with cultivator, and laid by with a diamond plow throwing the dirt to the corn; cultivation deep. In addition to this the corn was hoed and hand weeded twice, and thinned to three stalks in a hill.

Medium sized yellow corn used for seed; average length of ear, nine inches, and seven inches in circumference; height of average stalk, ten feet.

Previous crops: Clover in 1884; corn in 1885, and wheat in 1886. No manuring.

The corn was very chaffy, owing to the fact that no rain fell after July 3d, until after the crop had matured.

CROP STATISTICS FOR 1887.

Estimated area and yield of the principal crops of the State for the year 1887, as compiled from the returns of our large list of crop correspondents:

Name of crop.	Total acreage.	Yield per acre.	Total yield.
Wheat	1,662,721	17 bushels.	28,266,257 bu.
Corn	6,512,291	22.8 "	148,480,235 "
Oats	1,275,389	33.5 "	42,725,531 "
Tobacco	13,254	590 pounds.	7,819,860 "
Cotton		444 "	
Broom Corn		704 "	
Hemp		787 "	
Potatoes (Irish)	82,903	65 bushels.	5,394,545 "
Potatoes (sweet)		92.5 "	
Sorghum		84.8 gallons.	
Flax		9.2 bushels.	

Yield of apples	42. per cent.
Corn—quality compared with an average year	73. per cent.
Wheat—area sown compared with 1886	91.7 per cent.
Wheat—present condition compared with an average year	89. per cent.
Rye—area sown compared with 1886	95. per cent.
Cotton—area compared with 1886	102. per cent.
Castor bean—yield per acre	9.5 bushels.
Condition of pastures	70. per cent.

NOTE.—The matter of this report has largely overrun our estimate, and the articles: "The Amateur Farmer," by S. K. Fowler, of Knox county; "Progress of Agriculture," by C. H. Weber, of St. Louis county; "Horse Breeding," by Dr. A. W. McAlester, of Boone county, and Bulletin No. 31, on "Texas Fever," by Paul Paquin, M. D., V. S., intended for publication in this report are necessarily omitted. These are laid over for a future issue.

INDEX.

PAGE

Agricultural College—Review of its work....146-149
Agricultural and Mechanical Societies....9- 12
Agriculture, scientific—Intelligence in farming required....343-348
Animal nutrition—Constituents of animal body, 288.291; process of nutrition, 291; digestion, 293; excretion.... 294
Board of Agriculture—Members and officers, 4; by-laws, 5; statute regulations of, 7-8; meeting executive committee, 45; proceedings, April 29, '87, 46-56; proceedings, May 31, '87, 57-61; annual meeting, Nov. 8, '87, 66-69; proceedings, January 17-18, '88....70-144
Botany—Importance of knowledge of to farmers, 335; rapidity of growth of plants, 337; cross-fertilization, 339; depth to plant seeds.... 341
Breeding healthy animals, 236; heredity, 236-239; in and in breeding.... 237
Bulletins—No. 28, maintenance ration for pigs, 457; cost of feeding pigs eighteen months, 459; influence of temperature on maintenance, 460; relation of age to amount eaten, 462-467; cost of growth, 468; relative value of foods, 468; skim milk for pigs, 473; value of excess food, 474; relation of amount eaten to growth, 476; relation of excess food to growth, 481. Number 29: 484-490; philosophy of rotation, 485; rotation trial, 487; table of yields, 489; observations on crop rotation, 490. Number 30: Fertilization, 491-502; economic value of chemical fertilizers, 493-494; how to know their proper use, 495-6; experiments with....496-501
Changes needed in our system of farming—Crop rotation, 240; sheep raising increased, 241; restraint of dogs.... 241
Chemistry of the farm—Constituents of plants, 247; function of leaves of plant, 249; function of roots, 251; germination of seeds, 253; plant development, 253-4; sources of plant food: atmosphere, 256; soils, 256-261; manures: necessity of, 262; farm yard, 263; circumstances influencing its character. 264; special fertilizers, 264-270; crops: composition of per acre, 272-273; meadow hay, 274; root crops, 276; influence of climate and season. 279; rotation of crops: object of, 283; losses to land during rotation, 285; animal nutrition: constituents of animal body, 287-290; process of nutrition, 291; digestion, 293; respiration, 294; foods: composition, 295 299; digestibility by cattle, sheep, horses, pigs. 301-307; heat and work producing capacity of foods, 308-312; requirements of young animals, 313; adult animals, 315; fattening animals, 316-320; production of wool, 321; production of milk, 322; relation of food to manure, 323-328; constituents of milk, 329; cream, 330; butter, 331; buttermilk and cheese.... 332
Cooking food for pigs....389-396
Corn—Shallow culture....183, 211-223
Corn premiums—Award of in 1887....502-7
Corn—Fall plowing for.... 212
Crop rotation—Bulletin No. 29....484-490
Crop statistics for Missouri for 1887.... 508
Culture, deep and shallow contrasted.... 371
Dairy—Constituents of milk, 337; modes of raising cream, 331; cheese making, 333; composition of cheese.... 334
Dairy calves, cost of raising....403-410
Drainage—Experiments in....422-426
Depth of planting corn, 352; potatoes....352-356
Dairying, influence on corn.... 372
Ensilage—Compared with dry and green fodder....379-386

PAGE

Experiment stations. Extracts from American—Influence of selection of seed, 349-351; depth of planting, 352; planting at different dates, 354; cutting seed potatoes, 356; root pruning, 358; root development, 359-366; wheat alternated with fallow, 366-369; deep and shallow culture contrasted, 370; subsoiling, 371; influence of drainage, 372; shrinkage of corn, 373; sorghum sugar industry, 374-378; green fodder, dried fodder, ensilage, 379-384; ensilage versus fodder corn, 384 386; whole corn versus corn meal for steers, 387; cooked versus raw corn for pigs, 389-395; digestibility of Timothy hay, 396; whole and ground corn for pigs, 397 400; rations for poultry raising, 401-402; cost of raising dairy calves, 403-410; relative value of feeding stuffs, 411; pig feeding, 412; feeding for fat and for lean, 412-420; comparative value of foods, 420; relative weight of different parts of pigs, 421; distance from calving to milk yield, 422-424; value of acre of fodder turned into butter, 424; setting milk, 425; amount of excrement passed daily by cows, 426; cost and value of stable manure 428

Farmers Meetings—At New London, 146-156; at Kirksville, 156-161; at Cora, 161-163; at Trenton, 163-172; at Gallatin, 172-3; at Charleston, 174-178; at Dexter City, 178; at Poplar Bluff, 178-181; at Lebanon, 182-187; at Mt. Vernon, 187-199; at Neosho, 199-204; at Sarcoxie 205-207; at Sheldon, 208-209; at Appleton City, 209-214; at Windsor, 215; at Soleville 216-217

Farm Homes—Model home 152-156

Farm Water Supply—Importance of ample supply, 230; source of water, 232; poisons in, 232; wells and cisterns 234-235

Feeding Experiments ..... 379, 421, -463

Feeding Stuff—Relative value, 411; composition and value ..... -420

Feeding for fat and for lean 412-419

Fertilizers—Chemical—Bulletin No. 30 491-502

Fodder—Green and dried compared with ensilage 379-386

Foods—Composition of, 293; digestibility, 300; Comparative nutritive value, -307

Garden—Vegetables—Varieties to plant, 176; depth of planting seed ..... -177

Grass—Relative area, 15; versus tillage crops, 16; relation to crop rotation, 17; hay a home consumption crop, 18; comparative nutritive value, 19; digestibility, 20; comparative yield, 21; cultivation of, 21; fine tilth, 22; manuring for, 24; economy of selling hay, 25; varieties to sow, 26-28; clover in mixed grasses, 29; amount of seed to sow, 30-32; when sow, 32; when harvest, 32; best time to cut, 32-38; curing hay, 35; degree of dryness desirable, 39-40; storing hay, 41; care of meadows ..... 42—43

Grinding foods for steers, 387, 389; for pigs 397-400

Hay—Home consumption crop, 18; economy in selling, 25; why cut before blooon, 33; curing, 38; digestibility of 396

Heredity—definition of the law, divisions of, 238; influence of 239

Insects Injurious to Vegetation—Definition, 219; insects of the orchard, apple root louse, borers, 221; codlin moth, 222; cankerworm, curculio, 224-225; insects of the field, 226-227; of the garden 228-229

Manures—Necessity for, 262; farm-yard, 263; chemical fertilizers, 265-270; relation of food to, 323 328; amount of excrement passed daily by cows, 426; cost and value of barn-yard 428-431

Marmaduke, Gov. John S.—Memorial page 3

Milk—Experiments in setting 425

Milk yield—Influence of distance from calving on 422-424

Occupation—Comparative ages by 432

Poultry raising—Rations for 401

Report of secretary twentieth annual—Review of season of 1887, 13; effect on crops 14

Rollins, Hon. James S.—Resolutions of respect 123

Rotation of crops—Advantage of, 281; green crops, 282; losses to land during, 285

Rotation of crops, Bulletin No. 29 484-490

Root-pruning—Corn 358

Root development, observations on 359-366

Sheep-husbandry—Competion with Australia, etc., 151; effect of mis-management on wool, 152; decline in numbers of sheep, 203; effect of duty on, 204

Seed selection, influence of—On yield of peas, 349; on yield of oats, 350; on character tomato, 351; seed, cutting potato, experiment on 356-357

Sorghum sugar, present state of industry 374-378

Subsoiling, experiments on 370

Tillage, relation of to soil conservation—Soil disintegration, 191; free access of air, temperature, 192; surface washing, 193; soil leaching, 194; volatilization, 195; nitrogen accumulation 196

PAGE
Wheat altered with fallow.....366-369
Woman on the farm.....452-456
Wool—Examination of, 433; comparative yield from different breeds, 435; scale of fibre, 436; length, crimp and fineness, 437; average diameter from various breeds, 439; influence of fold in skin on quality of wool, 440; tensile strength, ductility and elasticity defined, 441-444; standard for commercial grades; influence of crossing on character of wool.....446-452

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